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ART. I.—*Review of Chambers's Ancient Sea Margins,* with Observations on the study of Terraces;* by JAMES D. DANA.

THE author of the work on "Ancient Sea Margins," has entered upon a subject of great scientific interest. It rises beyond the study of isolated deposits or local phenomena, and embraces facts bearing upon the geological history of whole continents, indicating wide changes in the earth's surface, and the latest of this general nature our globe has undergone. The truth, moreover, is exhibited in characters which cannot be mistaken even by the mind unaccustomed to geological evidence. It is marked in the condition of the soil and the extent and features of the fields of our valleys; and even the higher country along the smaller streams bears evidence that the same causes have there modified the main outlines of the land, and determined its variations of character. The farmer is well aware of the distinction of upper and lower plain or prairie along our streams, and knows that he often may distinguish the different flats by the peculiarities of soil they present.

It is a long time since the terraces of valleys and sea-shores were first noticed; yet hitherto only isolated cases, or particular valleys have received much attention. Mr. Chambers is the first who has collected together the various observations, and from these and other results of his own, has endeavored to arrive at a general deduction for the whole. He concludes that those of

* Ancient Sea Margins, as Memorials of Changes in the relative level of Sea and Land; by Robert Chambers, Esq., F.R.S.E. 338 pp., 8vo. Edinburgh and London, 1848.

different countries point, in many instances, to a single cause operating simultaneously over distant regions. He observes:

"There is nevertheless enough to justify a question regarding uniformity of level, not only throughout North America, but also—bold as the idea, in the present state of knowledge and of hypothesis, may appear—between the old and the new continents. It has certainly appeared to myself, to say the least, as a promising prognostic of some important new views regarding a chapter in the past history of the globe, when, it being granted that terraces and benches of land are marks of ancient levels of the sea, I find that a tendency to a bench form or plateau, at 60, or from 60 to 70 feet above present high water, exists on the coasts of the United States and in the Gulf of St. Lawrence, as it does in Britain; that conspicuous terraces in Britain and in France at 188 and 392 feet, are repeated in America; that there, also, at about 545 feet, are several repetitions of a decided and most notable Scottish terrace—that Scott built his house of Abbotsford on an ancient sea-beach beside the Tweed, which finds an analogue in the first of the grand ridges sweeping from east to west behind Toronto; and that the sandy plateaux of Lanark and Carstairs are in metrical harmony with the terraces and ridges of the half-peopled wilds of Michigan."—p. 316.

This must be viewed as a bold inference, and should not be admitted without extended investigation. It is certainly a legitimate subject of enquiry, and one of the grandest in its range, before the geologist. If proved, it declares that the causes of variation in the water line, in the recent history of the globe, have acted at certain periods as widely as the ocean. If disproved, the facts indicate changes no less extensive, which have been produced at different epochs for different regions, and they show a still greater instability in the earth's surface, telling of oscillations in its various parts continued through ages since the tertiary epoch, until a whole continent has been terraced in all its valleys.*

* In connection with the subject of terraces, we add a remark here on the word *drift*, as it is often used. It is frequently applied to any loose material on the surface, not originating where found, whether *stratified* or *unstratified*. This name being affixed to any accumulations, one or another *drift-theory* comes in to account for the facts,—such as the currents and icebergs of an ocean over the submerged lands, the action of waves of translation, or the movement of glaciers. The term in its very nature implies a theory of this general character. But there is much material of the kind called drift, which may be of sea-shore or beach accumulation; there is much also which may be of river origin, and much that may be lacustrine. Instead of determining by observation the actual facts in the different cases, and carefully discriminating, the mind is led away by the term *drift* at once to prejudge, to the confusion and error of observations. In its general signification, it had better therefore be rejected; such truthful terms as *earth*, *sand*, *gravel*, *clay*, *boulder accumulations*, are preferable, until it is fully determined that the material in any case is true drift, and not alluvial, lacustrine, or of beach or seashore origin. First prove it to be drift (often a difficult problem) and then so designate it, is a safe rule.

We have been led into these remarks by observing not unfrequently, that river terraces and beach deposits were ranked with the drift; and when once so-called, every succeeding step in investigation leads into deeper error.

Mr. Chambers introduces the subject with the following statements.

"The most familiar phenomenon connected with this subject is the existence of stripes, as well as broad expanses of low land, bordering on the sea; in many districts, of a very equable surface; sometimes of sandy, sometimes of clayey composition; occasionally presenting beds of shells: comprehending, in short, the great bulk of those flat tracts which have been—usually on account of the latter feature—recognized as ancient beaches; comprehending, also, the well-known *carses* of Scotland, as well as those still lower sandy tracts near the sea, called in our country *links*, and in England *downs*. The class of lands so described may be said to form an irregular fragmentary belting round the island, strikingly distinct from the higher grounds which rise inland—generally of great agricultural value, and remarkable as forming the sites of many of the principal towns of the empire, or of large portions of them. As they almost every where tell a plain tale as to their former submergence by the sea, the idea may the more naturally occur, that, were they by any accident re-immersed, a very important deduction would be made from the geographical area, and still more from the productive resources, of our island.

"As striking examples of this class of lands, I may point to the sea-side plain stretching for several miles on both sides of Chichester; to the similar plain extending along the south shore of the Bristol Channel, between Weston-super-Mare and Bridgewater; and to the broad expanse of low land in Lincolnshire and other parts of eastern England. The carses along the Forth and Tay—vast alluvial plains,—the low gravelly lands of Moray, and the alluvial grounds skirting the Clyde near Glasgow, are examples of equally signal character in the northern part of the island.

"It may, I believe, be safely said, that a sea 44 feet above the present would cover the whole of the districts referred to, excepting, perhaps, a few patches. The base of the comparatively steep ground rising from the interior line of these plains and stripes, even when they reach the highest grade of height, is usually at about that elevation above the sea, or a little lower. An immersion, therefore, to this extent would leave us with new coasts, not only much circumscribed, but considerably different from the present—for one thing, much bolder. It would also deprive us of the sites of the lower parts of London, Bristol, Liverpool, Newcastle, Glasgow, Aberdeen, and Inverness, and of the entire sites of Portsmouth, Southampton and Chichester, of Hull, Dumfries, Greenock, Leith, and Perth. The same submersion, extended to the Continent, would blot no small space from the map of Europe.

"Where we have large expanses of these low lands, the flatness is usually very striking. For instance, in an extensive plain beside the Bristol Channel, the equability is so great over large areas, that the Exeter Railway passes over it for twenty-eight miles (from Ashton Water to Claverham Court), with a gradual rise of only four feet; and even this perhaps is to be attributed to the lines taking an oblique course athwart the plain, and against its seaward declination. Such equability makes the land almost the rival of the sea in the trueness of its surface

to the centre of the earth, and forcibly suggests that water was concerned in giving it such a configuration. Such a plain is, indeed, precisely what would be presented to us as a piece of new land, if some of our shallow seas, such as the Bristol Channel, the mouth of the Humber, or the Solway Firth, were to sink forty feet below their present level. The carses in Scotland are also generally level, though not without partial inequalities, which a slight examination suffices to detect. In the configuration of the ground, thus level, with in many places the small inclination proper to a beach over which the tide rises and falls; in the cliffs which are often seen rising along the interior limit of the plain; in the constitution of the soil, composed of layers of sand or of clay, or of both, alternating often with beds of shells, we see clear evidence that these grounds were formed along the margins of an ancient sea; the highest inland part speaking of one about 44 feet above the present. Such is the announcement from these great expanses. When we look, however, to narrower examples of the great belting, such as are presented on bolder coasts, we find precise demonstrations, not only of an ancient sea-level about 44 feet above the present, but of several others intermediate between that and the present, particularly at 32, 27, 20, 11, and 8 feet—such appearing in the well-defined form of terraces or benches of land, the unavoidable result of the wearing power of the sea when it abuts against land of suitable slope and consistence. And, as already almost implied, these memorials of ancient sea-levels conform with each other in various parts of the island."—pp. 6–9.

The volume is occupied with details of facts from Scotland and other parts of Great Britain, and afterwards from Europe and foreign countries generally.

A brief abstract is here presented in a tabular form, first of terraces occurring in the vicinity of the sea, and next of those existing in the interior. We have preferred this arrangement, which differs from Chambers's own table, for reasons mentioned beyond.

1. *Terraces in the vicinity of the Sea.* (*Height in feet above high tide.*)

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Table Continued.

Musselburg,	20	. .	. .	. .	. .	110	. .	. .	. .	. .	. .	. .
Kirkaldy,	25	. .	56	64–80	100		125	. .	186–190	. .	. .	. .
Stoney hill villa,	. .	. .	56	. .	. .	. .	. .	. .	. .	. .	. .	. .
Between East Duddington and the sea,	. .	. .	. .	70–85 or 90	. .	. .	. .	. .	. .	. .	. .	. .
Edinburgh,	20	. .	56	70	110	. .	. .	165	186, 200		280	
The Tweed, Berwick,	30–32	44	56	. .	. .	. .	. .	. .	. .	. .	. .	. .
Frith of Clyde, Isle of Bute,	27–32	. .	. .	64	108	. .	. .	. .	. .	. .	. .	. .
Dumbarton,	32	. .	. .	64	104	. .	. .	. .	. .	. .	. .	. .
Glasgow,	11, 26	. .	. .	64–70 or 80	. .	. .	. .	. .	. .	. .	. .	. .
Loch Linnhe. Loch Leven at Ballachulish,	. .	42–44	. .	65	. .	. .	. .	. .	. .	. .	. .	. .
Loch Etive, Connel Ferry,	. .	43	. .	64–70	. .	. .	. .	. .	. .	. .	. .	. .
Fort William,	32	. .	. .	70	96	. .	. .	165	187	. .	. .	. .
Dev'nshire, Barastaple Bay,	. .	. .	. .	60	. .	. .	. .	. .	. .	. .	. .	. .
near Exeter,	. .	. .	. .	67	. .	. .	126	. .	. .	. .	. .	. .
Brixham, near Tor Bay,	. .	. .	. .	. .	. .	. .	. .	. .	170–180	. .	. .	. .
Hope's Nose,	. .	. .	. .	64	. .	. .	. .	. .	. .	. .	. .	. .
Lancashire, Ribble,	. .	. .	. .	60–70	100	120–128	. .	. .	. .		300	
Liverpool,	. .	. .	. .	60–70	100	120–128	. .	. .	. .		300	
Seacombe and Egremont,	. .	. .	. .	60–70–85	. .	. .	. .	. .	. .	. .	. .	. .
River Dee, at Chester,	. .	. .	. .	60–72	. .	. .	. .	. .	. .	. .	. .	. .
River Severn, at Bristol,	. .	. .	50–56	. .	. .	. .	128	. .	187–193		277–282	
River Thames, near London,	30	. .	. .	64–90	. .	. .	. .	145–150	. .	. .	. .	. .
Sussex, near Brighton,	. .	. .	. .	64	. .	. .	. .	. .	. .	. .	. .	. .
" Chichester,	. .	43	. .	. .	. .	. .	112–128	. .	. .	. .	. .	. .
" Chicham,	. .	. .	. .	. .	. .	. .	128	. .	. .	. .	. .	. .
Hamps're, Southampton water,	. .	. .	. .	66	. .	. .	. .	. .	. .	. .	. .	. .
Isle of Wight,	. .	. .	. .	64	. .	. .	128	. .	. .	. .	. .	. .
Rouen,	. .	43	55	69	. .	. .	126	. .	. .	. .	. .	. .
Norway, near North Cape,	. .	. .	50	78	. .	. .	. .	. .	. .	. .	. .	. .
Spitzbergen,	. .	. .	. .	. .	. .	. .	128	. .	. .	. .	. .	. .

From the above table, there are evidently terraces of nearly the same height above the sea, common to distant regions. These heights are approximately 20 feet, 30–32, 44, 56, 64–70, 107–117, 126, 165, 185–190, 280 feet, and probably others.

2. *Terraces in the interior, remote from the Sea.* (*Ht. above high tide.*)

Valley of the Tay.—Junction with the Isla, (93 ft. ab. sea,) **146, 186.**
Dunkeld, (145 ft. above the sea,) **165, 280–292.**
Logierait, **281.**
Beyond Killiecrankie, **497.**
Blair Atholl, **500.**
Taymouth, (Loch Tay 350 ft. above the sea,) **385.**

Fife—on the Eden.—West Lomond Hill, **466, 543, 758–60, 996, 1338?**
Ceres and Teasses, **203, 280–293, 325–330, 465, 545, 573, 599.**
Falkland, **203, 243.**

Strathspey.—Kingussie, (about 710–720 ft.) 760, 776, 792, 829, 853, 868.
Drumgellavy, opposite Kingussie, 997.
Farther up the valley around a lake, 1104, 1131, 1261.
Loch Ness, (45 ft.) 104, 377, 497, 530.
Dunnain, 121, 165, 189, 220, 279.
Dochnacraig, 205, 344, 461, 562, 626.
Erchet, above Loch Ness, 497.
Lochaber.—Loch Lochy, (82–89 ft.) 213.
Glen Spean and Glen Roy, 141, 167, 210, 325, 345, 372, 391, 428, 446, 520, 534, 627, 679, 703, 734, 750, 847, 1059, 1089, 1125, 1139, 1261, 1290, 1337.
Glen Gluoy, 959–969, 1159–1169.
Loch Tulla, Argyleshire, (630 ft.) 814, 907, 948, 1025, 1104, 1132.
Borthwick and Edinburghshire, 628, 656, 687, 706, 760, 821–6, 872, 968½.
Basin of Forth.—Stirling, 106–117, 165, 211.
Markinch, Leslie and Kinross, 285, 385–389, 448, 497.
Vale of Tweed.—Kelso, (83 ft.) 108, 122, 168–178.
Melrose, (270 ft.) 346, 391–393, 445, 497.
Galashiels, 542.
Eildon Hills, above Peebles, 542, 628, 675, 708, 787, 829, 872–5, 914, 967, 1024, 1087, 1133, 1166, 1196, 1226, 1282, 1336.
Lauderdale, 800–900.
Yarrow, 630, 656, 685, 709, 779, 824, 879, 958, 1081, 1126, 1186.
Dumfriesshire, Cannobie, 144, 165, 192, 219, 277, 320, 392.
Evan Vale, 1073, 1023.
Basin of Clyde.—Lanark, 675–687.
Lamington, 820, 872, 999, 1025, 1139.
Crawford, 826, 844, 910, 937, 962, 1025, 1090, 1107, 1171, 1204, 1251, 1286.
Newton, 912, 963, 1025.
Vale of Allan, Northumberland and Weardale Durham, 760, 826, 1073.
Valley of the Seine, (upper part,) 117, 126, 186–192, 238, 281, 307, 347–350, 393, 440–443, 461–465, 531, 545, 564, 576, 599, 629½.

Mr. Chambers's work contains extended descriptions of the localities mentioned, illustrated by excellent drawings.

Among the most remarkable of the terraced valleys of Scotland, are those of Glen Roy and the adjoining valleys, whose terraces are called the Parallel roads or shelves of Lochaber. This region attracted the attention of Macculloch in 1817, who published an elaborate article upon them in the Geological Transactions.* Since then they have been the subject of study by Sir Thomas Lauder Dick,† Mr. C. Darwin,‡ Buckland, Agassiz,§

* Trans. Geol. Soc. London. Vol iv, 1817, p. 314.
† Trans. Royal Society of Edinburgh, 1818, volume ix, p. 1.
‡ Trans. Royal Society. London. 1839. p. 39,
§ Jameson's Edinb. New Phil. Jour., 1842.

Mr. Kemp,* Mr. David Milne,† Sir George S. Mackenzie,‡ and James Thompson, Jr.§ Speaking of these Lochaber terraces, Macculloch says:—

The appearance of the parallel roads is so extraordinary as to impress the imagination of the most unphilosophical, nay even of the most incurious spectator. * * * On each side of a long, hollow, deep valley, bounded by dark and lofty mountains, and at a great elevation, three strong lines are traced parallel to each other and to the horizon, the levels of the opposite ones coinciding precisely with each other. So rarely does nature present us in her large features with artificial forms, or with the semblance of mathematical exactness, that no conviction of the contrary can divest the spectator of the feeling that he is contemplating a work of art, a work of which the gigantic dimensions and bold features appear to surpass the efforts of mortal power.

Several views of the region are given by Macculloch. The following is from Chambers, who says of the three lines, that they

extend for five or six miles on both sides of Glen Roy, and look like "copy lines ruled for text." The *first* and *second*, or two upper, were found by Macculloch to be 82 feet apart, and the *second* and *third* 212 feet. A careful survey by Mr. David Stevenson, according to Mr. Chambers, made the latter 212·37 feet, and the former 80·32 feet—a close approximation to Macculloch's determination. The height of the uppermost above high tide is 1139 feet; of the *second* 1059 feet; of the *third* 847 feet.‖

* A writer in the Athenæum, of September 23, claims for Mr. Kemp of Galashiels, his having first investigated the inland terraces of Scotland, and states that his views, which are the same as are presented by Mr. Chambers, were noticed in Chambers's Journal as early as 1840.

† Jameson's Edinb. New Phil. Jour., vol. xliii, 339, 1847.

‡ Ibid, xliv, 1, with a map, Jan., 1848. A previous memoir by Mackenzie was read on the subject before the Royal Society of Edinburgh, in 1842, and a still earlier publication appeared in Brewster's Phil. Jour. for 1833.

§ Ibid, vol. xlv, p. 49, 1848.

‖ Macculloch observes, that the first is 927 feet above the level of the junction of the Roy and Spean.

Adjoining Glen Roy lies Glen Gluoy, which opens below upon Loch Lochy. This valley has two distinct shelves or terraces, one 1159 feet above high tide, and the other 959–969 feet. Other shelves occur in Glen Spean, as well as in Glen Roy, whose heights are mentioned in the table on page 6. The whole system has afforded a fruitful, and most interesting subject of speculation. The "perfect horizontality" of the terraces, (their height above the present bottom of the valley therefore diminishing upward, instead of rising with the valley,) their extent, and the character of the region around, are the basis of the two views recently urged, the one attributing them to inland lakes, the other regarding them as beaches of an arm of the sea.

Mr. Chambers adopts the latter view: and as he discusses the character of the other terraces of Scotland and England, he arrives at the same conclusion for them all. He finds the same "ancient sea-margins" in foreign regions. In France and North America he seems to detect terraces of equivalent height with those of Scotland, and all are set down as marking *former levels of the sea*. A natural terrace and a sea-beach are therefore in his view nearly synonymous terms.

We do not pretend to deny, without examination, the conclusion in particular cases carefully studied by Mr. Chambers. But the sweeping deduction needs much, very much, restriction. And even many of his own examples demand better proof of the former presence of the sea than has been presented.

The principle that 'what has been, may again be, and the reverse,' is acknowledged to be a safe test of truth in geology. If the last elevation of sixty feet (or thirty if it be so) which Scotland has experienced, produced elevated sea-beaches, and no proper *river* terraces,—if all the existing river terraces are remains of other sea-beaches and proofs of other higher elevations,—then another elevation of sixty feet would produce a similar result, and this alone. In order to ascertain the truth, the necessary effects of such a change of level may be briefly reviewed. These effects are as follows:—

1. The formation of elevated beaches on many parts of the sea-coast about sixty feet above the sea, varying in height somewhat as actual sea-shores vary, according to their position with reference to the winds and tides.

2. The beds of rivers being raised, as well as the rest of the land, the amount of descent to the sea would be increased; and in consequence of this, their waters would run more violently, the excavating force would be augmented, and they would go on with a process of rapid degradation, until the former rate

of descent was reached. Towards the mouths of the streams the bed might be deepened the whole sixty feet. Above, the amount would vary for any given period according to the ability of the waters in different parts to wear out the material over which they pass. A hard rocky bed might prevent excavation; and if the material were yielding above such a place, the wear might there level down the surface and produce a range of slow waters, ending in rapids over the harder unyielding rocks. The amount of excavation might thus vary from sixty feet, the maximum depth, to only a few feet along the tributaries.

3. Besides depressing their beds, the rivers would act laterally, and carry off the alluvium of their banks, (when any existed,) and every flood would aid in this result, until finally, a broad flat or "bottom-land" in many places bordered the streams. Such a flat, situated within the reach of the river floods, is common on parts of all rivers where their descent is not too rapid. The breadth of the flat would depend on the amount and force of the waters during floods, and it would necessarily be bounded by a steep slope rising to an upper level. Where the valley was narrow, all the former alluvium might be carried off; where broad, some portions would be left.

4. The result would be the same whether the rise were gradual or abrupt. If the latter, the river would have more rending power towards its mouth, and the deepening would go on more rapidly. If a slow gradual rise should commence at any time, the river, through its increasing excavating power, would begin to sink between its banks, and the wear of the alluvial flat either side by floods would also commence. The terrace slope would also show its first beginnings, as an outline to the river flats. Finally, the stream would have a bank of its former height,—this height being a constant quantity for the stream;—it would have more or less broad flats, which flats or bottom-lands would commonly be bounded by a slope; and, if the former alluvium remained, there would be a shelf or terrace above.

5. From the conditions mentioned in the last paragraph, it is evident that during a gradual elevation, (and as gradual a sinking of the stream,) the outline of the lower flat might be varied, in consequence of a change in the bed or banks of the stream which should vary its direction or the direction of its principal current; and, that therefore in the course of one and the same rising, a terrace of sixty feet might form in one place, and in another, perhaps not far distant, one of twenty, and another of forty;—or one of ten, and another of thirty, and another of twenty; and so on. In still other places the upper alluvial plain

might descend by a very gradual inclination to the lower flat, instead of forming a proper terrace; or part way it might be gradually declining, and then fall off with the rapid slope that usually bounds a terrace. These are all possible results of the causes mentioned and are to be looked for in nature.

6. The lakes of the country, where they could at once empty themselves, would correspond with the rivers in the results produced, and each terrace might indicate in many cases a separate elevation. When they remained closed by a barrier, they would either gradually become emptied, or by abrupt steps at intervals; and hence there might be several terraces differing in height from any along the rivers, (indicative of the progress made at successive periods,) and differing from those of a neighboring lake.

7. The terraces of a river without lakes, in the case supposed, would have the terrace plains approximately parallel with the bed of the stream. Where there were lakes, the terraces would be horizontal, and the stream left in the valley might ultimately have (as in Glen Roy) a rapid descent. It should be remembered, that the descent of large rivers, and consequently the corresponding slope of their flats, is but *one or two feet to the mile;* and hence great accuracy in leveling may be necessary to detect a variation from horizontality.

By way of farther illustration, suppose North America to rise sixty feet, (or the sea-level to sink this amount.) The Mississippi has now a lower flat in some places exceeding twenty miles in width; on the Ohio the flat is often over five miles, on the Connecticut over a mile: and so with other rivers. The great river of the west, would soon work its bed down the sixty feet. Its banks,—since their height has a relation to the existing level of the river—would be reduced to their present elevation; and some miles back a terrace of sixty feet would mark the limits of the new formed lower flat. The same result or something analogous would take place on the Ohio and all the other rivers of the country. Even the streamlets that constitute their head waters, high up among the hills, would each form its terrace where there were proper alluvial shores; for the slope of the whole from the summit rill to the mouths of the rivers at the sea, would gradually have become increased by the elevation of the country, and the process of excavation would therefore affect every part of the land. There would not necessarily be an identity of height in the terraces formed, for the reasons stated in §§ 2 and 5.

If these are facts,—and who can doubt it—the formation of every elevated beach along a coast, must be attended by the form-

ation of numberless terraces along the rivers of the elevated country. If so,—for the sixty feet rise Scotland has experienced, there must be river terraces of cotemporaneous origin even over the higher lands of the country; every river will tell the tale as well as the beach along the coast. If so,—the terraces described by Chambers as occurring over these upper regions, cannot all be proofs that the sea there left beaches: and it remains for investigation to establish by other evidence than the mere existence of such "benches" or "shelves" of land, that any are of that origin. Indeed the whole work, as far as the subject bears upon the question of elevation, remains yet to be done, excepting the observations relating to the exterior of the island. If there have been elevations of the land corresponding to the sea-shore terraces of 20, 32, 56, 64, 117, 126, 188 feet, there must for the reasons stated, be traces of river-terraces high up on the land, corresponding to each elevation, making a most complex problem for investigation to unravel. These facts have led to our separating the sea-shore terraces from the others, in the table given on a preceding page.

8. Another consideration comes in, complicating still more the problem. Suppose the coast to be raised independently of the country back, or to a greater height. This is a possible case, and should be a matter of investigation. It is obvious that the river excavations would be confined to the parts towards their mouths, and here the terraces would be found. At certain places, the slope of the river's bed would be diminished instead of increased; and in such parts the water would be set back;—its bed would fill up;—its flats would be flooded more frequently than before, or perhaps constantly, and they would consequently increase in height by new accumulations. Near the sea, in such a case, the river terraces might slope with the bed of the stream, while in other places they would be absolutely horizontal, and higher up the valley be wanting altogether.

9. One important conclusion, obvious without farther remark, is that the terraces in the higher portions of a country are not satisfactory evidences of as many distinct elevations—nor of the actual height of any elevations the country may have experienced. The terraces toward the sea are more trustworthy.

There is a certain rule in the examination of rock deposits—well understood and generally applied—which is entirely neglected by Mr. Chambers and many others in the study of terraces. It is this:—that the marine origin of a bed is *to be proved* by its resemblance to marine formations and its containing marine relics. Consider for a moment the characters of a line of coast.

1. In many places above the water line, there are beach accumulations; and these accumulations are sandy and distinctly stratified. The layers though thin and distinct are irregular, not of very great lateral extent, but frequently blending and changing their direction. There is often a slope in the layers having the inclination of a beach.

2. There are drift heaps on many exposed coasts, formed by the winds and higher seas above the true beach accumulations. These also are stratified (or laminated when solidified), each sheet of sand blown over forming a separate layer. The layers are very irregular in dip, often curving (like the top of the drift heap), and frequently changing their direction. They are often cut off abruptly and overlaid unconformably by other layers, as a sand drift is often beheaded by a gale, again to increase by new accumulations. Such drift heaps sometimes form interrupted ridges along a coast, forty, fifty or sixty feet in height.

3. Below the water level, there are often flats or slopes of gravel, sand, or silt. The material is frequently in delicate layers, and the layers may be of wide or small extent, often (when in extended banks) scarcely varying from horizontality yet sloping where the bottom slopes. They are frequently rippled by the waves, or agitated into parallel ridges, in some cases even at a depth of five hundred feet, and flexures like those of the rippled surface will be apparent in the layers beneath. Again, when the waves on a shore break and flow over a bank in shallow waters, they roll up the sand in a series of slopes; such banks may therefore be composed of horizontal layers, while the layers themselves occasionally consist of subordinate inclined layers.

4. The sandy beaches in some places contain worn shells; but very frequently they are destitute of such remains, owing to the trituration of the sands destroying those that may be thrown up. The muddy deposits often afford more or less of animal life of various kinds, and among them shells are common, worn or unworn.

The muddy deposits containing molluscs and those beach accumulations that include worn shells, will together, constitute a certain proportion of a line of coast, and the former a larger proportion of the estuaries. The proportion for any coast should be ascertained, that it may be used as a key towards studying the accumulations over the country back.

5. There is a minimum width for long arms of the sea, which should be compared with the width of interval between opposite terraces on rivers.

Allowing now for a large part to be carried off by waters after an elevation, it is evident that there will still remain in some parts among sea-coast formations, indications of their marine origin. Such evidence is yet to be found in our upper terraces. And until it is obtained, there is no safety in the inference that the terraces,

extending as they do throughout the interior of a whole country, are marine. It will be time enough to speculate on the facts, when they are ascertained. The terraces consist of material of all kinds, from the coarsest pebbles to the finest silt, and assuredly the sea, if the source, must have left some traces of itself and its productions, which may be detected where such extensive deposits remain undisturbed.

The writer has observed terraces along the rivers of Oregon and California as well as in the eastern portion of our country, and for some years has been hoping to take up the subject for special study, feeling assured that a phenomenon which so pervades a continent, as is evident throughout the United States from east to west, must afford conclusions of the highest interest to geology. Mr. Chambers's work contains much valuable material, showing at least the wide distribution of terraces over his own country, as well as to some extent in other lands. But more study is required before the great body of the facts he has collected are made available to science. The subject should be entered upon in the manner exemplified by that accurate and laborious Scotch geologist, Macculloch,* and carried out with still more minuteness of detail.

1. The heights of the terraces above the bottom of the river valley on both sides, should be measured by careful leveling, and sections should be thus made through the whole course of a stream from its mouth to its head, at as many places as practicable.

2. The height of the river above the sea should also be obtained for each place, where a section is thus made.

3. The horizontality or slope of the terrace plains along the valley should be determined: and to this end the length of any breaks in a line of terraces, met with on the ascent of a stream, should be noted, and the physical features where such breaks occur, in order to understand the causes of them: also the nature of the river's bottom, upon which fact it often depends whether the terraces may or may not correspond in slope with the existing slope of the stream, and also what may be their height in different places.

4. The relation should be ascertained, if there be any, between the heights of terraces on the smaller tributaries and those of the main stream, or between the stream where the descent is rapid and where it is nearly horizontal; also between small and large streams in the same vicinity.

5. The character of the deposits, whether alluvial, lacustrine, or of beach or sea-coast origin, applying the tests mentioned, should be matters of thorough investigation. Assuredly, if no marine relics or indications are found along a river's terraces for one or two hundred miles, it would be defying all geological principles to assert that such deposits were marine.

* See Geol. Trans., vol. iv, pl. 21.

A river valley should thus be surveyed from its mouth to the heads of all of its tributaries. The Connecticut in our own country affords a most interesting region for investigation; for the terraces are on a magnificent scale, and may be traced, as the writer has seen, even among the White Mountains. One river thus studied, will be a standard of comparison; and when a whole country has been carefully examined from the shores to its higher summits, we shall have certain and satisfactory data for some grand deductions. We may then hope to learn which terraces belong to one and the same epoch, and to what extent they are measures of the elevations of a country. After these points are determined, we may look for a full elucidation of the former changes of level a continent has undergone during the period included, or perhaps may prove coincidences between distant countries that will point to some principles in geological dynamics yet but half acknowledged.

The writer has said nothing upon the effects of glaciers, as they will be better learned from those who have made them their study. The course of investigation pointed out precedes the application of any theory to account for the facts.

We do not attempt a review of the known facts relating to terraces in this country, since they can establish little more than the general truth of their existence, until a systematic series of observations is carried out.

New Haven, November, 1848.

ART. II.—*On a New Formula for Interpolations;* by J. H. ALEXANDER, Esq.

I HAVE given to the following formula, the epithet of *new*, not as claiming any thing for it in that behalf; for, in so far, it is neither the better nor the worse: but simply, because it *was* new to me at the time I developed it for my own use. That it will be new to others now, by no means necessarily follows; indeed, from the readiness with which the elements submit themselves to the requisite decompositions and transformations, rather the opposite is to be presumed. The principle of the method is certainly as old as Descartes; and the form of it, even, may occur in some of the mathematical writers, not long after him but now ancient for us; although, from comparatively slight familiarity with those writers, I am not aware of its existence. At all events, however, it does not appear in some of the most recent treatises on the special subject, where one would naturally expect to find the fruits both of ingenuity and of research; and therefore having recognized, for a good while and frequently, the ease and fecun-

dity of my method, I suppose it will not be an unwelcome addition to our existing analytical apparatus. It may be so expected, especially at this period, when there is less lack of observations in the physical sciences than of elegant, or even expert, methods in their subsequent employment; and, in so far, what follows may be considered as a contribution to a fruitful and extensive part of the Art of Observing.

Interpolation is, in general, analytically the supplying of missing or required quantities within or beyond (either positively or negatively) a series whose given quantities progress according to some certain, but unknown, ratio. When the ratio is known, it is of course more convenient to find the required quantities by the equation it furnishes. Such quantities, if numerical, are (or are assumed for the purpose of interpolation to be) terms in a series of figurate numbers; and the order of the series, as well as the equation by which it is generated, is determinable by the number of removes after which the differences of the successive terms become constant, or, in most practical cases, by the actual number of terms given in the series. In geometry, a similar application of it is made for the determination, by rectangular co-ordinates, of a line subject to the condition of passing through a given number of points.

In this last aspect, if the number of points given be no more than two, it is manifest that the conditions of the question are met by a straight line. If the points are more than two, and the construction does not shew the co-ordinates for such points to be in the relation of the base and perpendicular of a right-angled triangle, the development of the line required must be by a curve traced from point to point by means of an ultimate reduction to this same relation. It is plain that such curves may be as varied as the number and positions of arbitrary points given for their determination; but the order to which they belong and the character of the curve itself, follow from the degree and co-efficients of the equation which is found to express the respective values of its abscissa and ordinate. Thus in all the curves determined by normal sections of an equilateral cone, the equation for the ordinates is of the second degree; all arcs of a circle, therefore, are lines of the second order, and so are those of an ellipse and common parabola; but the character of the former of these is still farther defined by the co-efficient expressing the ratio between its transverse and conjugate diameters, and of the latter, by the co-efficient of its parameter. The cubic parabola, however, still coupled with a similar co-efficient, presents an equation for ordinates of the third degree, and is therefore a line of the third order.

I may remark here, in passing, that writers on analytical geometry have not unanimously retained these distinctions in view;

but have sometimes treated the subject as if *curves* were essentially different from straight lines. Hence, what are really *lines* of the second order, have been termed by some, *curves* of the first degree; and so on. It hardly need be said that this is in so far a defect in the generality of the method; and that it imposes the necessity of a subordinate and at least cumbrous discrimination between *degrees* and *orders*, the first being the appellations of the equations, and the second, of the curves dependent upon them.

For the present aim, such discriminations would but tend to confuse. And the geometrical aspect which the formula affects, is that of the hypothenuse of a triangle or the arc of a curve, having a general characteristic equation of the form $y^n = ax$ (and therefore parabolic), but divisible into as many different degrees or orders as there are assignable values of n. The origin of the co-ordinates is placed at the apex of the triangle, and at the pole of the curve, in the respective cases; in the last the characteristic equation assumes the form $y = \overline{ax}^{\frac{1}{n}}$, which brings the ordinates to the linear scale and makes the base on which they are measured, tangent to the curve at the pole; while the different abscissæ, x', x'', x''', etc., are in fact portions of diameters intercepted between the arc itself and points in the base of the ordinates corresponding to the values of y', y'', y''', etc.

But geometrical illustrations are, in general, intelligible with difficulty, unless accompanied by delineations; I prefer, therefore, to place the explanation of the formula upon the theory of figurate numbers; to which, as already said, the doctrine of interpolations belongs. Of course the derivation of the formula will be equally satisfactory, whether it be made to flow from extension or from numbers; and the numerical deduction will have the advantage of being of the same kind with the cases that occur most abundantly in practice.

These *figurate* numbers, then, are the terms of various artificial series, constructed from and corresponding to the natural series of numbers in such wise that if the general term of this last be called $\frac{n}{1}$, the general term of the others will be expressed by $\frac{n}{1}\cdot\frac{n+1}{2}$; $\frac{n}{1}\cdot\frac{n+1}{2}\cdot\frac{n+2}{3}$; $\frac{n}{1}\cdot\frac{n+1}{2}\cdot\frac{n+2}{3}\cdot\frac{n+3}{4}$; and so on. Thus for instance, substituting in the expression, $\frac{n}{1}\cdot\frac{n+1}{2}$, the successive values of n (1, 2, 3, 4, 5, etc.,) from the natural series, we have a figurate series, as under;

natural series:	1.	2.	3.	4.	5.	&c.
figurate series:	1.	3.	6.	10.	15.	&c.

If we use the next expression $\frac{n}{1} \cdot \frac{n+1}{2} \cdot \frac{n+2}{3}$., we shall develop a

figurate series: 1. 4. 10. 20. 35. &c.

And the expression following would give rise to still another

figurate series: 1. 5. 15. 35. 70. &c.

It is seen in the algebraic notation of these, that not only the individual terms of each, but the general terms of all, are in a regular progression. Thus the first or natural series, comprehends only the lowest power; the next involves the square of the given term and so presents an equation of the second degree; the third offers an equation of the third degree; and so on. This is precisely accordant with what was just now deduced in the consideration of straight lines and curves.

The powers of n, occurring in these different equations, correspond also to the degrees of removal from the original series at which the differential series becomes constant. Thus taking again the natural series: 1. 2. 3. 4. 5. &c.

1st differential do.: 1. 1. 1. 1. &c.

That is to say, the differences are already constant at the first remove.

If we take a series of the second order, involving the second power of n, we have

second order: 1. 3. 6. 10. 15. &c.
1st differential: 2. 3. 4. 5. &c.
2d differential: 1. 1. 1. &c.

and the differences become constant at the second remove.

These instances are sufficient to show the generality of what is affirmed; that the index of the power involved in the equation, indicates also the number of removes at which the differences of the terms become constant. It is upon this, that the ordinary method of interpolation is founded; but the distinction between that method and the formula now proposed, is that while the former requires the use of the differences themselves and in cases of intermediate interpolation the tabulation of the results, the latter employs in all cases only the original terms, and uses the differences only so far as may serve in the absence of other means to determine the degree of the equation and of the figurate series in which the quantities given are to be arranged.

The order of the series and the number of terms necessary for solution are, it is manifest, correlatives; and the law which connects them is, that the index of the order $+1$ is the said number. Thus, in a series of the first order, the given quantities in which, progress lineally or by one constant difference, only two terms are necessary for interpolation of the remaining terms;

just as, geometrically, two fixed points are enough for determining the position and direction of a straight line. In a series of the third order, it is necessary to use four terms; and in one of the fourth order, five terms, for its development.

The choice, however, in any case, of the proper number of terms to be involved in the calculation, is not arbitrary; but depends in each instance upon the character of the series in question. Where such a series corresponds with equidistant ordinates, in general successive differences of its terms may be taken; and the degree of removal where such differences are constant, is the degree of the equation applicable and the order to which the series itself belongs. Thus if we have corresponding to

the ordinates:	1″.	2″.	3″.	4″.	5″.	&c.,
a series:	16 ft.	64 ft.	144 ft.	256 ft.	400 ft.	&c.,

(whose terms, in fact, represent the spaces passed over by falling bodies in the respective times) we shall have also

1st differences	48.	80.	112.	144.	&c.
2d "		32.	32.	32.	constant.

The equation of this series is of the second degree, then; and any three terms of it, are sufficient for the interpolation of the rest.

So, if we take the series of expansions of iron, (whose length is 1.— at 0° Centigrade,) corresponding to the temperatures indicated respectively by the

ordinates:	100° C.	600° C.	1100° C.	1600° C.	2100° C.	&c.
expansion series:	0·00114	0·01148	0·03006	0·05751	0·09446	&c.

we shall have,

1st differences:	1034.	1858.	2745.	3695.	&c.
2d "		824.	887.	950.	&c.
3d "			63.	63.	constant.

Its equation, then, is cubic; and four terms are necessary to interpolation of other terms of such a series.

The same conclusion may be arrived at by other considerations, sufficiently probable to serve as guides. As the ordinates actually expressed in degrees Centigrade are equidistant, they may be transformed into the natural series, having its first term at 100° C., thus 1, 2, 3, 4, &c.; and we can then judge what power of this natural series will correspond the nearest with the actual expressions. The presentment may be conveniently made in the following form:

Actual ordinates:	100°	600°	1100°	1600°	2100°	:
Transformed terms:	1	2	3	4	5	:
Squares:	1	4	9	16	25	:
Cubes:	1	8	27	64	125	:
Fourth power:	1	16	81	256	626	:
Actual experiments divided by 1st term:	1	10·07	26·37	54·48	&c.	:

It is evident upon this, that an equation of the second degree would be much below the divergence of the series; and that one of the fourth is still more above it. We are, therefore, warranted in regarding it as cubic, and in interpolating accordingly.

This method applies more emphatically to cases where the ordinates are not equidistant. For instance, taking a series from experiment on the resistance of still water; in which the ordinates represent miles per hour in the speed of the vessel, and the abscissæ are the resistances measured in pounds respectively; we have

ordinates:	mile. 1·925	miles. 2·222	miles. 2·628	miles. 4·045
resistance-series:	lb. 11	lb. 13·08	lb. 18·10	lb. 47·26

Transforming these, in dividing each by its first term, we produce

ordinates:	1	1·154	1·365	2·101
squares:	1	1·33	1·86	4·41
cubes:	1	1·54	2·54	9·49
resistances:	1	1·19	1·64	4·30

It is very plain from this, that the resistances increase more rapidly than the simple ordinates, but do not transcend the ratio of the squares. The series of cubes has been given only for abundant illustration. We are limited, then, in this instance to an equation of the second degree.

These methods will cover the most of cases occurring in practice; nearly all which already, in point of fact, do not transcend a series of the second order. Cases may occur, however, in which for various reasons they could not be applied safely; and where it is desirable to use all the terms given by observation. To such as these, the formulæ I propose are, I believe, peculiarly applicable. These formulæ I shall now at length present.

Calling a, b, c, d, ... &c., the first, second, third, fourth, &c., (equidistant) terms in a series; and l, any term whose place in the series, or rather the number of whose place, is n; we have generally

I. When *first* differences in the given series are constant,

$$l = \overline{n-1}\,.\,b - \overline{n-2}\,.\,a;$$

II. When *second* differences are constant,

$$l = \frac{\overline{n-1}\,.\,\overline{n-2}}{1\,.\,2}\,.\,c - \overline{n-1}\,.\,\overline{n-3}\,.\,b + \frac{\overline{n-2}\,.\,\overline{n-3}}{1\,.\,2}\,.\,a;$$

III. When *third* differences are constant,

$$l = -\frac{\overline{n-1}\,.\,\overline{n-2}\,.\,\overline{n-3}}{1\,.\,2\,.\,3}\,.\,d - \frac{\overline{n-1}\,.\,\overline{n-2}\,.\,\overline{n-4}}{1\,.\,2\,.\,1}\,.\,c + \frac{\overline{n-1}\,.\,\overline{n-3}\,.\,\overline{n-4}}{1\,.\,2\,.\,1}\,.\,b - \frac{\overline{n-2}\,.\,\overline{n-3}\,.\,\overline{n-4}}{1\,.\,2\,.\,3}\,.\,a;$$

IV. When *fourth* differences are constant,

$$l=\frac{\overline{n-1}.\overline{n-2}.\overline{n-3}.\overline{n-4}}{1\ .\ 2\ .\ 3\ .\ 4}.e-\frac{\overline{n-1}.\overline{n-2}.\overline{n-3}.\overline{n-5}}{1\ .\ 2\ .\ 3\ .\ 1}.d+\frac{\overline{n-1}.\overline{n-2}.\overline{n-4}.\overline{n-5}}{1\ .\ 2\ .\ 2\ .\ 1}.c-$$
$$-\frac{\overline{n-1}.\overline{n-3}.\overline{n-4}.\overline{n-5}}{1\ .\ 2\ .\ 3\ .\ 1}.b+\frac{\overline{n-2}.\overline{n-3}.\overline{n-4}.\overline{n-5}}{1\ .\ 2\ .\ 3\ .\ 4}.a.$$

Such are the formulæ covering a case where as high as *five* terms of the original series, concur for the interpolation. It would be easy to extend them further; but the occasion for it will hardly occur in practice. I have left them in their present shape, in order to show more clearly the mode of their generation and their symmetry; besides, this shape will also be found as convenient for calculation. A transformation, however, can very easily be made; that may be preferable for those who make the entire calculation, for greater security, upon paper. The second series, for instance, will then assume the form;

$$\text{II. } l=\frac{n^3-3n+2}{2}.c-(n^3-4n+3).b+\frac{n^3-5n+6}{2}.a.$$

It is hardly necessary to cumber this paper with farther merely elementary processes.

It may be remarked that the form of these several series is apparently *divergent;* they are not less applicable, however, to series that *converge*. The change of signs follows such characteristics, and unerringly regulates the result.

I shall now offer in proof, some illustrations of the application of the formulæ to practical cases; in which there will be an opportunity of comparison with the methods of interpolation ordinarily employed.

1. Weisbach, in his learned essay on Observations,* has given the following series of temperatures and pressures, furnished by certain experiments on steam; viz.

Pressures in atmospheres:	1·	1·5	2	2·5
Temperatures (Centigrade):	100°	112°·2	122°	129°;

and desires then to interpolate the temperatures proper to pressures of 1·1; 1·2; 1·3; 1·4 atmospheres, respectively. He assumes, also, that the differences in the temperature-series, are constant in the second place; and, therefore, employs in fact but the first three terms. As my object is only to compare my proposed method with the habitual one under the same assumptions, I shall not stop now to discuss the propriety of these; but shall give at once the numerical substitutions in my formula.

In arranging the equidistant pressures according to the natural series for ordinates, viz.: { 1. 1·5. 2. 2·5; &c. / 1. 2. 3. 4. ; &c.

*Allgemeine Maschinen Encyclopädie; von Hülsse u. A. Art. Beobachtung.

the epochs for interpolation required between the first and second terms, become (instead of 1·1; 1·2; 1·3; 1·4;) 1·2; 1·4; 1·6; and 1·8, respectively. These are the values then to be successively substituted for n in the formula II, in order to obtain the values of l in terms of the temperature. Taking, then, a, as 100°; b, as 112°·2; and c, as 122°; and calling $n=1{\cdot}2$, we have

$$l=\frac{1{\cdot}44-3{\cdot}6+2}{2}.122-(1{\cdot}44-4{\cdot}8+3).112{\cdot}2+\frac{1{\cdot}44-6+6}{2}.100$$

$=102°{\cdot}632.$

When n is 1·4, then

$$l=\frac{1{\cdot}96-4{\cdot}2+2}{2}.122-(1{\cdot}96-5{\cdot}6+3).112{\cdot}2+\frac{1{\cdot}96-7+6}{2}.100$$

$=105°{\cdot}168.$

When n is 1·6, then

$$l=\frac{2{\cdot}56-4{\cdot}8+2}{2}.122-(2{\cdot}56-6{\cdot}4+3).112{\cdot}2+\frac{2{\cdot}56-8+6}{2}.100$$

$=107°{\cdot}608.$

And finally when n is 1·8, then

$$l=\frac{3{\cdot}24-5{\cdot}4+2}{2}.122-(3{\cdot}24-7{\cdot}2+3).112{\cdot}2+\frac{3{\cdot}24-9+6}{2}.100$$

$=109°{\cdot}952.$

Assembling these results into a series, and letting the epochs of pressure return to their actual value, we have, as under—

Pressures in atmospheres:	1.	1·1.	1·2.	1·3.	1·4.	1·5.	2. &c.
Corresponding temperatures:	100°;	102°·632;	105°·168;	107°·608;	109°·952;	112°·2;	122°. &c.

It is hardly necessary to say that these interpolated results are exactly the same with those that Weisbach arrives at, after a more complicated process.

2. Wallace, in his article on Interpolation, for the Edinburgh Encyclopedia, has quoted the following lunar distances of Aldebaran, viz.

1847. Nov. 1. Noon, 53°·20′·16″; Midnight, 59°·33′·47″;
Nov. 2. " 65°·52′·58″; " 72°·18′·10″;

and has then calculated the corresponding distances at the third, sixth and ninth hours, respectively, of the first interval. I shall compare his results with those of the present formula.

Ranking the given terms in a natural series of equidistant intervals of 12 hours, and reducing the angular values to seconds of space for convenience, we have as follows:

Ordinates,	1.	2.	3.	4.
Distances,	192016″.	21427″.	237178″.	260290″.

The epochs of the ordinates for interpolation are then 1·25; 1·50; 1·75, respectively. I need only give, for illustration, the substitution of one of these epochs in the formula III; which as there are four terms is the one properly applicable. Taking, then, the value of n at 1·5, and substituting for a, b, c, d, the numerical distances in their order, we have

$$l=\frac{0\cdot5\,.\,-0\cdot5\,.\,-1\cdot5}{1\,.\,2\,.\,3\,.}\,.\,260290-\frac{0\cdot5\,.\,-0\cdot5\,.\,-2\cdot5}{1\,.\,2\,.\,1\,.}\,.\,237178$$

$$+\frac{0\cdot5\,.\,-1\cdot5\,.\,-2\cdot5}{1\,.\,2\,.\,1\,.}\,.\,214427-\frac{-0\cdot5\,.\,-1\cdot5\,.\,-2\cdot5}{1\,.\,2\,.\,3\,.}\,.\,192016;$$

$$=0\cdot0625\,.\,260290-0\cdot3125\,.\,237178+0\cdot9375\,.\,214427$$
$$+0\cdot3125\,.\,192016;$$
$$=16268''\cdot125-74118''\cdot125+201025\cdot3125+60005;$$
$$=203180\cdot3125=56^\circ\,26'\,20''\cdot31$$

A similar substitution for the other epochs will enable us to transform the series, as under:

Nov. 1st—Noon.		3 P. M.	6 P. M.	9 P. M.	Midnight.
Distances,	53°·20′16″	54°·53′7″·96	56°·26′20″·31	57°·59′53″·20	59°·33′47
do. Wallace,	"	54°·53′8″	56°·26′20″	57°·59′53″	"

It is thus seen that the formula, with but little (if any) more figure-work, is not deficient either in accuracy or in precision. The arithmetical operations might even have been abbreviated, by dividing at once all the terms in the series of distances by the first term. The answers would have been produced by multiplying at least each result by the same constant factor. But artifices of this kind belong, of course, to the working of any formula.

Such a division, however, might have been useful for another purpose, as I have already mentioned; namely, to determine the order of the equation to be employed. As in the present instance, the object was only a comparison of methods, and as all four terms had concurred in the method of Wallace, they were of course used equally and without question in my own. It is however easy to see that many practical cases may occur, in which more terms are given than would be necessary, or even proper, to employ under the physical relation of the question. In the example just now from Weisbach, there were four terms given too, but only three were employed. In the last example, the terms were no more than necessary, as will be seen by the following transformations and parallelisms.

Epochs in time.	1.	2.	3.	4.	&c.
Distances divided by 1st term.	1.	1·116	1·235	1·356	&c.
$\sqrt{}$ epochs:	1.	1·414	1·732	2·—	&c.
$\sqrt[3]{}$ epochs:	1.	1·260	1·442	1·587	&c.
$\sqrt[4]{}$ epochs:	1.	1·184	1·316	1·414	&c.

It is manifest upon inspection, (and still more by executing numerically the ratios,) that a cubic equation developes a series the most nearly approaching that of the distances themselves.

These two examples, drawn from astronomy and general physics, are sufficient to illustrate the method of interpolations by the present formula, when the terms of the given series are equidistant. I shall now present some cases, which have furnished examples already to others; and in which, the ordinates are not equidistant. In point of fact, in a great many physical observations, it is extremely difficult to preserve such isotomy; and there is hardly ever a case of experiment or observation, though admitting in one of its series a progression by regular multiples, in which all the successive terms can be accepted by the observer, as of equal reliability. The application of the formula to broken series of this kind, is, therefore, of the highest interest.

3. An instance may be taken, already cited by Wallace, where the distances of a comet from the sun's centre, were as follows, at the given epochs, viz.:

At midnight on	December	12,	the distance	was	301;
"	"	21,	"	"	620;
"	"	24,	"	"	715;
"	"	26,	"	"	772;

and he has applied the ordinary method for interpolating the distance on 20th December at midnight. I shall use for the same purpose, the formula III.

In order that the first term of the series for epochs should be unity, the origin of the co-ordinates has to be taken as of 11th December; and the two series will then correspond as under:

Epochs of time-intervals:		1.	10.	13.	15.
Distances	:	301.	620.	715.	772.

The epoch to be interpolated corresponds, then, to 9 in the series; but for the application of the formula, we have first to ascertain the values of b, c, and d corresponding to the epochs 2; 3; 4, respectively; the value of a is already known to be 301. For this purpose we construct with the three other distances given, as many equations as there are unknown quantities, substituting in each the successive values of n as 620; 715; 772, respectively, as under; and then eliminating the quantities in question:

$$n=10.;\ \text{and}\ 620=\frac{9.8.7}{2.3.}.d-\frac{9.8.6}{2}.c+\frac{9.7.6}{2}.b-\frac{8.7.6}{2.3.}.301;$$

$$n=13.;\ \text{and}\ 715=\frac{12.11.10}{2.3}.d-\frac{12.11.9}{2}.c+\frac{12.10.9}{2}.b-\frac{11.10.9}{2.3}.301;$$

$$n=15.;\ \text{and}\ 772=\frac{14.13.12}{2.3}.d-\frac{14.13.11}{2}.c+\frac{14.12.11}{2}.b-\frac{13.12.11}{2.3}.301;$$

The numerical transformations of these, result in three main equations, viz.

$$(\alpha).\quad 17476 = 84\,d - 216\,c + 189\,b;$$
$$(\beta).\quad 50380 = 220\,d - 594\,c + 540\,b;$$
$$(\gamma).\quad 86858 = 364\,d - 1001\,c + 924\,b;$$

Multiplying (α) by $4\frac{1}{3}$; and subtracting from (γ), we eliminate d; and leave $(\delta)\quad 11128\frac{2}{3} = 105\,b - 65\,c.$

Again multiplying (α) by the fraction $\frac{5}{21}$; subtracting from (β); and multiplying the remainder by $2\frac{1}{3}$, we obtain

$$(\varepsilon).\quad 10755\tfrac{5}{9} = 105\,b - 66\,c;$$

and subtracting this last from (δ), we eliminate b; and deduce

$$c = 372\tfrac{8}{9}.$$

By similar substitutions, $b = 336\frac{7}{9}\frac{7}{4}\frac{6}{5}$; and

$$d = 409\tfrac{2}{3}\tfrac{2}{5}.$$

With these values we can now interpolate any term. For the one in question we have $n = 9$; and $l = \frac{8.7.6}{2.3}.409\frac{2}{3}\frac{2}{5} - \frac{8.7.5}{2}.372\frac{8}{9}$ $+\frac{8.6.5}{2}.336\frac{7}{9}\frac{7}{4}\frac{6}{5} - \frac{7.6.5}{2.3}.301$; whence the distance required, or the 9th term, $(l) = 586\frac{3}{1}\frac{1}{6}\frac{1}{5}$ or 586·295. The result of Wallace, 586·3 may be said to be absolutely identical.

4. I shall give but one more example of this kind. In an experiment of Coulomb, it was observed that with ropes of 12·5, 20, and 28 lines in circumference, passing over a pulley of four inches diameter and strained with a constant weight, the rigidities were equivalent to 11; 27; and 50 pounds, respectively: what will be the equivalent rigidity, other things being the same, of a rope 16 lines in circumference?

Here we have the two series, corresponding as under:

	In.	In.	In.
Circumferences:	12·5.	20.	28.
do. divided by 1st term:	1.	1·6	2·24
Rigidities:	11 lb.	27 lb.	50 lb.

In this case, the value of a (formula II.) is known; the value of b and c are obtainable from the equations of 27lb. and 50lb. to the corresponding values of n; viz. 1·6 and 2·24 respectively. These being determined they are substituted in the same formula, taking also the value of n at 1·28 ($\frac{1.6}{1.2.5}$), the epoch of the required ordinate. The processes themselves are so purely artificial and so similar to what was given in the last example, that they need not be exhibited here. It is enough to say that they result in making $l = 17{\cdot}77$ lb.

Weisbach's method has given the same value of this term at 20·391b.; which is manifestly erroneous and would accuse a convergence of a series which is plainly diverging. It could not by possibility be so much, even were the interpolated circumference

16·25 inches (the mean between 12·5 and 20), and the differences of the rigidities constant in the first place. I have not, however, farther investigated the causes of his error.

5. I shall terminate these numerical illustrations with one more instance; in which both coördinates undergo interpolation, simultaneously. This, as it is one of the most complicated cases, is also one of the most interesting applications of the formula which developes itself here with remarkable simplicity. The instance is the solstitial observation of Gassendi, in 1636, at Marseilles, of the shadow of a lofty gnomon. Supposing the gnomon divided into 89428 parts, he found the length of the shadow at noon on the respective days, as under:

Epochs.	June 19.	June 20.	June 21.	June 22.
Corresponding values of n.	1.	2.	3.	4.
Lengths of shadow:	31766	31753	31751	31759

The question is to ascertain by interpolation at what moment the shadow was the shortest; which is also the moment of the solstice.

It has been usual in questions similar to this, in order to avoid the resolution of equations of a degree higher than the second, not to involve all the terms at once; but to group them into sets, the mean of whose several results may be taken as the absolute one. It need hardly be said that such grouping and permutation lead only to partial solutions, which however approximate, do not exhaust at once all the elements given. The present method allows of the simultaneous employment of all these: but as there are only materials for one equation, while there are two unknown quantities, resort must afterwards be had to the higher analysis to determine when the shadow-length and the corresponding ordinate becomes a minimum.

Taking, then, our formula III, and leaving n in that, as unknown; and substituting for a, b, c, and d, respectively, the values of the shadow-lengths in the order given above; and executing the necessary numerical transformations, we obtain the sum of the terms which, when the unknown quantity is a minimum, must be equal to zero; as under,

$$-\tfrac{1}{6}n^3+6\tfrac{1}{2}n^2-31\tfrac{1}{3}n+31791=0.$$

Changing the signs, and differentiating in the ordinary methods, this leads to an equation of the second degree, viz.

$$n^2-26n=-62\tfrac{2}{3},$$

whose resolution gives a positive value of $n=2{\cdot}69$; which is to be counted in the direct order from 18th June, and corresponds of course with June 20^d, 16^h, $33^m{\cdot}6$, as the moment of the solstice.

It is evident that the order in which the terms should be taken in a case of this kind, is quite arbitrary and ought to be immaterial to the result. Accordingly, if we invert the present order and

assign to a, b, c, and d, the values of the shadow-lengths, counting from 22 June; and execute the numerical transformations as before, we shall have the terms to be made equal to zero, as under:

$$\tfrac{1}{6}n^3+4n^2-21\tfrac{1}{6}n+31776=0.$$

Differentiating, we have

$$n^2+16n=42\tfrac{1}{2}$$

and $n=2{\cdot}31$; which counting from 23 June, corresponds with June 20^d, 16^h, $33^m{\cdot}6$, as before.

The epochs obtained by Wallace, are, calculating by
1. the first, second and fourth terms, June 20^d, 17^h, 15^m: and
2. the first, third and fourth " " 20^d, 17^h, 25^m.

But I cannot consider the concurrence of these partial methods as comparable with a result from a general solution.

In point of fact, the present formula admits, from its geometric construction, of being applied to cases like this, with results approximate enough for most practical purposes and without any aid from the higher analysis at all,—a contingency where the ordinary formulæ fail. For instance, it is plain from the march of the terms just now given that they indicate points in the two arms of a parabola whose apex is the very solstitial point in question. In reality, these are not in the two arms of *one* parabola; but in the opposite arms of two parabolas of different parameters, whose axes and poles coincide. This condition, however, only affects the process, not the principle.

As we have only two points in either arm, we cannot interpolate nearer than by first differences that determine only a straight line—a path very variant from the hypothetical motion of the sun or the real motion of the earth. But as this motion is elliptical, and therefore subject to equation not higher than of the second degree, we may hence derive an approximate use of these differences to serve in solution.

Starting, then, on 19th June, with the series of shadow-lengths as abscissæ, the difference between the first and second terms is 13; which represents from the 19th to the 20th June, the measured change in declination *ascending*. Between the 21st and 22d June, the difference of the third and fourth term is 8; but the change is to declination *descending*. Between the 20th and 21st, the difference is only 2; and although it might by possibility be that the ascending declination (or descending series) was continued on to the 21st June, and that the turning point took place there or farther on, we are restrained from such an assumption from the large difference between the third and fourth terms, too great to consist with an incipient reversed motion. The crisis then must have occurred, as we have all along supposed, between the second and third term; and although this third term is yet less than the second, it bears in fact a contrary sign. The descend-

ing series and the curve corresponding to it, pass beyond the second term and meet the ascending ones through the third, in some stationary and tangential point whose abscissa is that of the solstice. The tangent at this point is, of course (i. e. its abscissa is) less than that of the third term: how much below, the negative differences of declination afford probable data for determining.

Having four abscissæ and three intervals, we have also for the variation in length of these abscissæ during the first interval, 13; and during the third, 8; as the actual motion is elliptical, the variation during the second, will be the square root of the difference of the other two (i. e. $\sqrt{13-8}=\sqrt{5}$;)$=2{\cdot}23$; stopping in an equation of the second degree, at the second decimal place. This is the whole change in declination between the second and third abscissa; and the difference of this (2·23), and the apparent difference of the two abscissæ (2), is the distance in declination below the third: corresponding to an actual abscissa of the solstitial point of $(31751-0{\cdot}23)=31750{\cdot}77$ parts. With this determination, the case is removed from its anomaly; and there is no obstacle to the employment of the formula, involving all four terms, to find the corresponding ordinate. With the ordinary methods, there would still be required the resolution of a cubic equation; under the present formula, all terms containing a power of n higher than the second, are eliminated.

It is manifest that as we have now the absolute numerical value of the abscissa at the point required, the sum of the terms containing n (the ordinate of the same point), which for differentiating was made equal to zero, becomes now equal to the said abscissa. So that, recurring to the last solution, we have thence these two equations:

$$\tfrac{1}{6}n^3-6'n^2+31\tfrac{1}{3}n-31791=31750{\cdot}77;$$
$$\tfrac{1}{6}n^3+4\ n^2-21\tfrac{1}{6}n+31776=31750{\cdot}77.$$

Arranging all the terms involving n, on one side, we have

$$\tfrac{1}{6}n^3-6\tfrac{1}{2}n^2+31\tfrac{1}{3}n=40{\cdot}23;$$
$$\tfrac{1}{6}n^3+4\ n^2-21\tfrac{1}{6}n=-25{\cdot}23.$$

Subtracting the latter from the former, and then changing the signs, we have left

$$10\tfrac{1}{2}n^2+52\tfrac{1}{2}n=-65{\cdot}46$$

and dividing $n^2+5n=-6{\cdot}23$; an equation with no power of n higher than the second, and which, although its second member has an apparently negative sign, leads yet to a positive result, viz. $n=2{\cdot}64$; corresponding when reduced to time to June 20^d, 15^h, $21^m{\cdot}6$, a result sufficiently approximate to be employed.

Such are the examples and illustrations which seemed to me of sufficient interest to be connected with the formula and with this account of it.

ART. III.—*On the Fossil Remains of Birds collected in various parts of New Zealand by Mr. Walter Mantell, of Wellington;* by GIDEON ALGERNON MANTELL, Esq., LL.D., F.R.S., Vice President of the Geological Society.

From the Quart. Jour. Geol. Soc., London, No. 15, Aug., 1848.

IT is not a little remarkable that one of the most interesting palæontological discoveries of our times, namely, the former existence of a race of colossal Ostrich-like birds in the islands of New Zealand, though made in a British colony, and announced to the scientific world by an eminent British physiologist, has not hitherto been brought under the immediate notice of the Geological Society of London. I therefore consider myself particularly fortunate in having an opportunity, through the researches of my eldest son, Mr. Walter Mantell, of submitting for the examation of the Fellows of this Society, perhaps the most extraordinary collection of the fossil remains of struthious birds that has ever been transmitted to Europe, containing the crania and mandibles, egg-shells, and bones, of several genera and species, most of which, if not all, have probably been long extinct.

The first relic of this kind was made known to European naturalists by Professor Owen, in 1839. It consisted of the shaft of a femur or thigh-bone, but a few inches long, and with both of its extremities wanting; and this fragment so much resembled in its general appearance the marrow-bone of an ox, as actually to have been regarded as such by more than one eminent naturalist of this metropolis. If I were required to select from the numerous and important inductions of palæontology, the one which of all others presents the most striking and triumphant instance of the sagacious application of the principles of the correlation of organic structure enunciated by the illustrious Cuvier,—the one that may be regarded as the *experimentum crucis* of the Cuvierian philosophy,—I would unhesitatingly adduce the interpretation of this fragment of bone. I know not among all the marvels which palæontology has revealed to us, a more brilliant example of successful philosophical induction—the felicitous prediction of genius enlightened by profound scientific knowledge.

The specimen was put into Professor Owen's hands for examination, with the statement "that it was found in New Zealand, where the natives have a tradition that it belonged to a bird of the Eagle kind which had become extinct, and to which they gave the name of Movie;" and from this mere fragment, and with this meagre history, the Hunterian professor arrived at the conclusion, "that there existed, and perhaps still exists in those distant islands, a race of struthious birds of larger and more colossal stature than the Ostrich or any other known species." This inference was based on the peculiar character of the cancel-

lated structure of the bone, which differs from that of mammalia, and most closely resembles that of the Ostrich. And so confident was Professor Owen of the soundness of his inductions, that he boldly added, "so far as my skill in interpreting an osseous fragment may be credited, I am willing to risk the reputation for it on this statement;" and he further remarks, "The discovery of a relic of a large struthious bird in New Zealand is one of peculiar interest, on account of the remarkable character of the existing fauna of those islands, which still include one of the most extraordinary and anomalous genera of the struthious order, the *Apteryx;* and because of the close analogy which the event indicated by the present relic offers to the extinction of the Dodo of the island of Mauritius. So far as a judgment can be formed from a single fragment, it seems probable that the colossal bird of New Zealand, if it prove to be extinct, presented proportions more nearly resembling those of the Dodo, than of any of the existing *Struthionidæ*." In 1843 the correctness of these views was confirmed in every essential particular by a large collection of bones obtained by the Rev. W. Williams and transmitted to the Dean of Westminster; and still further corroborated by another interesting series brought to England in 1846 by Percy Earl, Esq.; and by the collection which forms the immediate subject of this communication.

My eldest son, who went to New Zealand in 1839, and settled at Wellington, in one of his earliest letters to me after his arrival, mentioned that a tradition was prevalent among the *Maories* or natives, that gigantic birds, taller than a man, were formerly abundant throughout the islands; and that some of the oldest of the natives averred that they had seen such birds; and that although much reduced in numbers, some of the race still existed in the unfrequented and inaccessible parts of the country. They called these birds *Moa*, and affirmed in proof of their statement, that enormous bones were occasionally met with in the mud and silt of the streams and rivers; but my son was unable to obtain any of the bones in question.

Upon learning from me of the discovery of the bone described by Professor Owen, he endeavored to obtain further information on this interesting subject; but until 1846, when he resigned an official situation, he was unable to follow up his inquiries with success. In the meanwhile the collections of the Rev. W. Williams, Mr. Percy Earl, and of other gentlemen, had furnished the materials from which Professor Owen drew up his two celebrated memoirs on the *Dinornis*, an extinct genus of tridactyle Struthious Birds, which were published in the third volume of the Transactions of the Zoological Society.

In 1846, and the commencement of 1847, my son explored every known locality of these relics in the North Island within

his reach, and went into the interior of the country and located with the natives, for the purpose of collecting specimens of the then unknown parts of the skeletons, and of ascertaining whether any of these gigantic birds were still in existence; resolving, if there appeared to be even a remote chance of this being the case, to penetrate farther into the interior and obtain one alive. The information he gathered from the natives offered no encouragement to follow up the pursuit, at least in that part of the country, but tended to confirm the idea that the gigantic struthious birds had become extinct, the last of the race having, like the Dodo, been destroyed by man within a comparatively recent period; and that if any of the species whose bones are found in a fossil state are still living, it is probable they will be those of small size, and related to the *Apteryx*, the living diminutive representative of the colossal bipeds that once trod the soil of New Zealand.

With these introductory remarks, which appeared to me necessary to place the history of the discovery in a clear point of view, I propose, first, to notice the geological conditions under which these fossil bones appear to have been accumulated; secondly, to describe in general terms the most remarkable features of the collection before us; and lastly, to offer some observations on the bearing of these facts on that difficult problem, that "*mystery of mysteries*," as it has been emphatically termed by Sir John Herschel, the appearance and extinction of certain types of organic beings on the surface of the globe.

I. *Geological position of the deposits in which the bones occur.*—In attempting to arrive at a correct knowledge of the relative geological age of the deposit in which the bones sent to this country were found imbedded, I have experienced considerable difficulty, in consequence of the unsettled state of the orthography of the various localities, and also from the indefinite manner in which the collectors describe the places whence they obtained the specimens. Unfortunately the letter from my son containing details of this nature, and to which in his subsequent correspondence he refers me for the necessary information, has not reached me. I endeavored to mark on a map of New Zealand all the localities whence bones had been obtained, but several places mentioned by the collectors are not inserted. I will therefore briefly state the circumstances under which the bones are described as occurring by the gentlemen who have transmitted them to this country.

The Rev. W. Williams, in his letter of Feb., 1842, states, "that none of the bones have been found on dry land, but are all of them from the beds and banks of freshwater rivers, buried only a little distance in the mud. The largest number are from a small stream in Poverty Bay, the River Wairoa, and from many

inconsiderable streams, all of which are in immediate connection with hills of some altitude."

A mutilated cranium, described by Professor Owen,* was obtained by Mr. Williams from the bed of a mountain-stream descending to the coast of Poverty Bay in the North Island. Another, sent over by W. Swainson, Esq.,† is from the vicinity of the Bay of Islands. "Both of these have a ferruginous tint and great weight, arising from an infiltration of peroxyd of iron; but the cancelli of the bone contain only a little of the dry powdery alluvium of the stream into which the specimens have been washed."‡

The Rev. W. Colenso, who in 1841–1842 accompanied Mr. Williams in search of the Moa, has given a very interesting account of the circumstances under which the bones were procured in the bed of the Waiapu river by the natives, by whom they were sought for to make fish-hooks.§ He states, that travelling southward from Poverty Bay, he came within sight of *Wakapunake*, the mountain celebrated among the natives as the residence of the surviving Moas; but no bones were obtained from thence. "The Maories affirmed that Moas lived there, but admitted that no one had seen any of these gigantic bipeds. The Moa's bones were to be found only after the floods occasioned by heavy rains, when they were to be seen after the waters subsided, washed up on the banks of gravel and mud on the river-side; but none were then to be procured. I offered large rewards for any that should be met with, and directed them to be taken to Mr. Williams in Poverty Bay. At the base of the mountain is the river *Wangarao*, which is a branch of the Wairoa, and runs into Hawke's Bay; and down this we paddled for some distance, but perceived no bones. Finding that we were willing to pay largely for specimens, a hundred persons set about hunting for them, and brought those they collected to Mr. Williams." Mr. Colenso states, that hitherto (in 1842) bones have only been found within the waters and channels of those rivers which discharge themselves into the southern ocean between the East Cape and the south head of Hawke's Bay, on the east coast of the North Island. They only occur on the banks of gravel, &c. in the shallowest parts of the rivers after floods occasioned by heavy rains, and when the waters have subsided to their usual level.

"These rivers are in several places at a considerable depth below the present surface of the soil, often possessing a great inclination, as it is at once perceived by the rapidity of their currents. They have all a delta of greater or less extent at their mouths, from an inspection of which it is obvious that their channels

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* Zool. Trans., vol. iii, p. 308, pl. 38. † Ibid.
‡ Prof. Owen in Zool. Trans., vol iii, p. 308.
§ See Annals and Mag. of Nat. Hist., vol. xiv, New Series, p. 81.

have considerably changed. The rocks and strata in these localities indicate generally both secondary and tertiary formations; the former consisting of argillaceous schist, sandstone conglomerates, greensands, &c.; the latter of clay, marly *calcareous tufa*, sand, gravel, and alluvial deposits." The true situation of the Moa bones is not known with certainty, but Mr. Colenso infers that they are found in the lowermost tertiary deposit. The localities mentioned by Mr. Colenso lie to the east of the volcanic chain of Tongariro, and the rivers probably have their origin on the flanks of that volcanic region.

The collection formed by Dr. Mackellar was from the Middle Island, from a superficial turbary formation on the coast, which was submerged at high tide, and is near the settlement at *Waikawaite*. Mr. Percy Earl, who obtained his specimens from the same locality, mentions that this deposit, which is overflowed by the sea at high tides, had been covered by a layer of sand and shingle; but this covering had been swept away by storm-waves a short time before his arrival, and a bed of black peat was exposed, from the surface of which bones projected; these and other specimens were procured by digging close to the surface, or at a moderate depth in the peat; they were all Dinornis' bones.*

The account given by the Rev. Mr. Taylor of Wanganui, a settlement on the western coast of the North Island, near the embouchure of the river of that name, lying to the south of Cape Egmont, as New Plymouth does to the north, is, in substance as follows:—

In 1843 he procured a collection of bones during a journey to Turakina (?),† from having observed a fragment of large bone, which induced him to inquire of the natives if such relics were to be met with. The natives pointed out to him several little hillocks of bones scattered here and there over the valley at the mouth of the river Whaingaihu (?) where the sand had drifted. Mr. Taylor describes these heaps as being composed of bones of several kinds of Moa, as though the flesh of the birds had been eaten, and the bones thrown indiscriminately together. The bones were in so friable a state that only the large ones would bear removal; the smaller ones pulverize in the hand, and below the surface the whole was a mass of decomposed bone. "The subsoil was a loamy marl, beneath which was a stratum of clay that chiefly forms the cliffs of this part of the western coast; it contains numerous marine shells, and closely resembles in appearance the *galt* of the southeast of England. I have no doubt it was when that loamy marl formed the surface-soil that the Moa lived; for although it is laid bare by the river side, yet in other parts *it is wholly covered by several strata of marine and fresh-*

* Zool. Trans., vol. iii. † Ibid, iii, 327.

water deposits. I have found the bones of the Moa in this bed, not only in other parts of the western, but also in the eastern coast, at the East Cape, and at Poverty Bay. I have not heard of this deposit having been noticed north of Turakina (?).*"

All the specimens sent from the localities above mentioned, with the exception of those from the South or Middle Island, are in the state of the mammalian bones that occur in the ancient alluvial deposits of England. They are permeated and colored more or less deeply by a solution of iron, and the cancelli are filled by the mud or silt in which they were found imbedded. They are but little water-worn, and have not suffered much abrasion; having, probably, been protected by the muscles and soft parts during their transport to the places where they were deposited. In short, their state of fossilization corroborates the accounts given of the nature of the alluvial bed from which they were procured; they strikingly resemble in this respect the bones of the Irish Elk, Mammoth, &c. of our diluvium.

But the bones collected by my son present a very different appearance from any previously received from New Zealand; instead of being of a dark color, heavy, and permeated by silt and iron, they are, on the contrary, light and porous, and of a delicate fawn-color; the most fragile processes being entire, and the articulating surfaces as smooth and uninjured as if prepared by the anatomist; *egg-shells*, *mandibles*, even the *bony rings of the air-tubes* are preserved. In their general aspect these bones most resemble those from Gaylenreuth and other ossiferous caverns. The state of preservation of these specimens is evidently due to the material in which they were imbedded, which is a loose volcanic sand, containing magnetic iron, crystals of hornblende and augite, &c., the detritus of augitic rocks and earthy tuff. This sand has filled all the cavities and cancelli that have external openings, but is in no instance consolidated or aggregated together; it is easily removed from the bones by shaking, or by a soft brush. A very few water-worn pebbles of volcanic rocks were the only extraneous bodies found in the sand: there are no vestiges of shells or mollusca of any kind; but there is in the collection a small *Arca* imbedded in a sandy clay, and an ammonite coated with pyrites, so like a specimen of *A. biplex* from the Kimmeridge clay of England, as not to be distinguishable from a genuine British fossil.

The name of *Waingangoro*, the locality which my son mentions as that where he dug up the greater part of his collection, does not appear in the maps of New Zealand I have inspected; but from some incidental remarks in his letters, I have reason to infer that it is situated in the higher part of the valley of the

* See Prof. Owen's Memoir on the Dinornis, Zool. Trans., vol. iii, p. 327.

Wanganui, a river which has its source in the volcanic regions of Mount Egmont. It was at the embouchure of the Wanganui that Mr. Taylor obtained the bones in his possession. It will be remembered that the streams which yielded the relics procured by Mr. Colenso and Mr. Williams, lie to the east of Tongariro, and probably originate in that elevated volcanic chain, many parts of which are above the line of perpetual snow. The specimens collected by my son were found imbedded in and filled with loose sand, at a considerable distance from the bed of the river; in no instance do they exhibit any traces of silt or fluviatile mud. My son mentions having on one occasion obtained bones from a potato-pit sunk by a native remote from any stream.*

With the view of elucidating these remarks, and the inferences I shall presently venture to suggest, I will here concisely describe the geological structure of New Zealand, on the authority of Dr. Dieffenbach. This country, which is situated between 30 and 50 degrees of south latitude, forms a group of mountainous islands nearly as large as England and Wales. Its geological structure is with difficulty determined, owing to the primeval forests which fringe the coast; and where these have been destroyed, by impenetrable thickets of esculent fern. The fundamental rock is everywhere clay-slate, which is frequently traversed by greenstone dykes, as at Fort Nicholson, Queen Charlotte's Sound, and Cloudy Bay. On the banks of the rivers Eritonga, Waibo, and along some parts of the sea-coast, *there are horizontal terraces of boulders of trap-rocks 50 feet high.* Anthracite coal crops out in the harbor of Wangarua; and there is a seam of the same mineral intercalated in the hard grey sandstone on the east coast of the Northern Island. On the west coast of the same, the limestone contains a few shells, as pecten, ostrea, terebratula, with an *Echinus spatangus.* The coasts are in many places fringed with recent horizontal sediments, consisting of loam with fragments of wood and fern, &c. The small rocky islands of trachyte off the coast of the Northern Island also *bear marks of wave-action to the height of* 100 *feet above the present sea-level.* In the interior of the Northern Island there is a lofty central group of volcanic mountains, some of the volcanos being still in activity: the ancient lava-streams appear to have been principally erupted from the base of the craters. The highest mountains are Tongariro, which is 6,000 feet, and Mount Egmont, 9,000 feet high. The loftiest summits are covered with perpetual snow. There are many lakes, which appear to occupy ancient craters.†

The occurrence of terraces of loam and gravel of comparatively recent date, at an elevation of from 50 to 100 feet above the sea, along the coasts of New Zealand, prove that a considerable change

* Wonders of Geology, 6th edition, p. 129.
† British Association Reports for 1845.

in the relative level of the land and water has taken place since those terraces were deposited, and at no very remote period. The present rivers of the country are described as now cutting deeply the beds of volcanic detritus and silt in which the birds' bones are contained; and the latter are in some places covered by marine and freshwater deposits. The facts adduced appear to me confirmative of the opinion advanced by Mr. Colenso (in 1842), that the true situation of the ossiferous deposit is beneath the surface-soil of the fluviatile beds formed by the present rivers. In the more elevated regions the bone-deposit consists of pure volcanic sand and detritus; while in the low districts and along the coasts it is composed of fluviatile mud or silt, which in many places is covered by modern beds of shingle and gravel.

II. *Description of Mr. Walter Mantell's Collection.*—I will now describe in general terms the most interesting specimens in the collection formed by my son; the anatomical details, and the important physiological inferences resulting therefrom, will be laid before the Zoological Society by Professor Owen; to whom, as a tribute of respect due for his masterly interpretation of the bones previously transmitted from New Zealand, I have offered the examination and description of every object in the series that he may consider worthy his attention.

The specimens amount to between seven and eight hundred, and belong to birds of various sizes and periods of growth; some evidently of aged individuals, and others of very young animals, in which the epiphyses of the long bones are still distinct from the shaft. They were catalogued by my son as follows:—

Birds' bones.—*Crania and mandibles*, 19; vertebræ, 250; sterni, portions of, 7; pelves, more or less complete, 30; femora, 37; tibiæ, 42; fibulæ, 35; tarso-metatarsal, 40; phalangeal, 200; ungueal or claw-bones, 30; ribs, 30; *egg-shells*, fragments, 36 specimens.

Seals.—Jaws with teeth, portions of crania, vertebræ, ribs, scapulæ, bones of the extremities.

Terrestrial mammalia.—One femur.

The specimens received exceeded the number above specified, and with the exception of a few of the most fragile (and unfortunately the most precious, as, for example, the mandibles, pelves, sterni), arrived in an excellent state of preservation.

The birds' bones, so far as they have been hitherto examined by Professor Owen, are referable to five genera; the crania and mandibles of three of which were previously unknown.

1. *Dinornis.*—This name is now restricted by Professor Owen to the birds which possessed a skull and beak essentially different from any form either recent or fossil. Of this genus there is a nearly perfect cranium, with the upper mandible, and portions of two other skulls. The form of the cranium, especially of the

temporal and occipital regions, is wholly unlike any hitherto observed in the class of birds, and approaches that of reptiles. It is characterized by the nearly vertical occipital plane, the elevated position and form of the foramen magnum, and the great development below the occipital condyle, and the strong ridges which border the basi-occipital, and indicate a most extraordinary power in the muscles that moved the cranium. The temporal fossæ are very deep, and are strengthened by a prolongation of the mastoid process, which is united to the frontal, and forms what may be termed a lateral zygomatic arch. The tympanic bone has two distinct cusps for articulation with the double condyle of the os quadratum. The configuration of the upper mandible or beak (the lower one is unknown) is very peculiar, and has been aptly compared by Professor Owen to a cooper's adze; it is considered by him to have been especially adapted for grubbing up roots and tubers; we have evidence, in the powerful muscles attached to the occipital region, of its having been an instrument capable of being used with great force. There is a portion of the articular part of a large lower jaw, that probably belongs to *D. giganteus*.

To this genus belong many vertebræ of enormous size; ribs, bones of the pelvis, and hinder extremities, and some portions of sterni; they are referable to six or seven species, respectively named from their size and osteological character, *D. giganteus*, *D. robustus*, *D. ingens*, *D. casuarinus*, *D. geranoides*, *D. curtus*, *D. didiformis*.

Among the bones of the extremities of the large species, I would especially direct attention to the femur, tibia and fibula of a young bird. The femur is 14 inches long, 9 inches in circumference round the shaft, and 16 inches round the condyles. The tibia, in which the union of the epiphysis of the proximal extremity is still incomplete, is 30 inches long, 6 inches in circumference at the shaft, and 14 at the condyles. The tibia of a much younger bird gives still more colossal proportions; for it measures 12 inches in circumference at the condyles, and yet the distal epiphysis, which is always rapidly anchylosed to the shaft in birds, is still distinct. The proximal extremities of other tibiæ are 17 inches in circumference; and there are fragments of shafts 8 inches round.

2. *Palapteryx*.—In this genus the skull differs essentially from that of the Dinornis; the occipital region is narrower; the foramen magnum is situated in the centre, which in the Dinornis is occupied by the condyle; the basi-occipital is not so much developed; and there are other osteological peculiarities which I need not detail. The rostral part of both mandibles is preserved, and shows an approach to the Dromaius or Emeu. The ethmoid cavities, or upper nostrils of the skull, are very large, as in the

Apteryx, a peculiarity denoting a remarkable development of the organs of smell.

Of this genus there are imperfect crania, mandibles, vertebræ, bones of the extremities, &c.

3. *Aptornis.*—Among the bones of small size, those for example that are comparable in magnitude to the skeletons of the Bustard and Apteryx, there are several tarso-metatarsals, femora, tibiæ, pelves, &c., which indicate a new tetradactyle genus, very closely allied to the living struthious bird of New Zealand, the Apteryx. Some of these bones are referable to the *D. otidiformis*, or Bustard-like Moa, of Professor Owen's second memoir: I believe the name of *Aptornis* will be assigned to this genus.

The other birds' bones belong to genera and species of which there are still living forms in New Zealand and Australia.

4. *Notornis.*—This genus is established by Professor Owen from the skulls, and upper and lower mandibles, vertebræ and bones of the extremities, of birds belonging to the *Rallidæ* or Rails; and closely allied to the living *Brachypterix*, a species of Coot or Water-hen peculiar to New Zealand. The mandibles are sharp like those of the Raven, but are more compressed laterally; the cranium presents some interesting anatomical characters. The original was of the size of a bustard.

5. *Nestor.*—The collection contains two upper mandibles of a species of *Nestor*, a genus of nocturnal owl-like parrots, of which only two living species are known. One of these (*Nestor hypopolius* of Mr. Gould) is restricted to New Zealand; and the other (*N. productus*) to Philip Island, which is not more than five miles in extent; and Mr. Gould remarks that "so exclusively is the *Nestor productus* confined to this isolated spot, that many persons who have resided in Norfolk Island for many years have assured me that its occurrence there is unknown, although the distance from one island to the other is not more than three or four miles."*

Such is the brief account of the birds' bones that have been accurately examined by Professor Owen; but it is probable, when the vertebræ and other specimens that have as yet been only cursorily inspected are carefully compared with recent skeletons, other species and genera will be detected. Some of the vertebræ appear to belong to the existing species of *Apteryx*, *A. australis*.

Egg-shells.—The fragments of egg-shells imbedded in the ossiferous deposits had escaped the notice of all previous observers, which is not surprising, for they are of small size and of very rare occurrence. My son, in all his wanderings, only procured between thirty and forty pieces. As these precious relics will shortly be described by Professor Owen, I will only mention that

* Mr. Gould's Birds of Australia.

the edges of most of them are rounded, as if water-worn. They belong to different species, or perhaps genera: some of them are smooth, but others have the external surface marked with short interrupted linear grooves, resembling the eggs of some of the Struthionidæ, but still presenting very characteristic peculiarities.

No vestiges of the bones of the wings have been detected.

Seals.—The remaining part of the collection consists of jaws with teeth, scapulæ, vertebræ, ribs, femora, and other bones, of a species of large seal; whether distinct from the two kinds (*Phoca leptonyx* and *P. leonina*) that inhabit the southern seas, and occasionally visit the shores of New Zealand, I have not yet been able to determine. The bones were found mixed indiscriminately with those of the birds, and are filled with volcanic sand.

Femur of a Carnivore.—One other relic must be specified, *the femur of a dog;* the sole fossil bone of a terrestrial quadruped that has hitherto been discovered in the ossiferous deposits of New Zealand.

Burnt Moa, and Human bones.—I must not omit to mention a very remarkable incident. In one spot the natives pointed out to my son some little mounds covered with herbage, as containing bones, the refuse of feasts made by their ancestors; and upon digging into these hillocks they were found to be made up of burnt bones. These consisted of *Moas', dogs' and human bones* promiscuously intermingled. These bones, which have evidently been subjected to the action of fire, contain no traces whatever either of the earthy powder or ferruginous impregnation so constant in the fossil bones from the fluviatile silt, nor of the volcanic sand with which all the bones collected by my son are more or less permeated. Mr. Taylor (*ante* p. 32) mentions having found similar heaps of bones in the valley of the Whaingaihu, "*as though the flesh of the birds had been eaten, and the bones thrown indiscriminately together.*" If such was the origin of these heaps of bones, and they are to be regarded as the rejectamenta of the feasts of the aborigines, the practice of cannibalism by the New Zealanders will appear to have been of very ancient date, and not to have originated from the want of animal food on account of the extinction of the Moas, as Professor Owen so ingeniously and indulgently suggested in extenuation of this horrid practice by so intelligent a race as the New Zealanders.

III. *General Conclusions.*—From the scattered facts which I have thus brought together in order to throw some light on a question of such deep palæontological interest—upon the principle that the feeblest rays, when concentrated into a focus, will produce some degree of illumination—I think we may safely infer that the islands of New Zealand were densely peopled at a period geologically recent, by tribes of gigantic ostrich-like birds, of species and genera which have long since been obliterated

from the face of the earth; and that subsequently to this "*Age of Struthionidæ*," the land has undergone those physical changes, by which the areas occupied by the ornithic ossiferous deposits, and the beds of shingle and loam, which now form terraces from 50 to 100 feet above the sea-level, were elevated to their present positions. This inference seems to be corroborated by the fact that the existing mountain-torrents and rivers flow in deep channels which they have eroded in these pleistocene deposits; in like manner as the rivers of Auvergne have excavated their course through the mammiferous tertiary strata of that country.

The accounts given by Mr. Colenso, the Rev. H. Taylor and others, of the exposure of the bone-bed in the channels of the mountain-streams, and of the bones being left on the river-shoals after heavy floods, remind us of the conditions under which the mammalian fossils of the Sub-Himalayas were first brought under the notice of our eminent countrymen, Major Cautley and Dr. Falconer. And in New Zealand, as in India, the fossil remains of extinct animals are associated with those of existing genera; and the land is still inhabited by diminutive representative forms of the colossal beings which flourished in the pleistocene, or early human epoch; for the Apteryx and the Porphurio may be regarded as the living types of the Moa and the Notornis.

I do not deem it necessary to enlarge on the question whether the Dinornis and Palapteryx still exist in New Zealand; on this point I would only remark, that Mr. Colenso, who was the *first* observer that investigated the nature of the fossil remains with due care and the requisite scientific knowledge, (having determined the struthious affinities of the birds to which the bones belonged, and pointed out their remarkable characters, ere any intelligence could have reached him of the result of Professor Owen's examination of the specimens transmitted to this country,) has given, in his masterly paper before quoted, very cogent reasons for the belief that none of the true Moas exist, though it is probable the last of the race were exterminated by the early inhabitants of these islands.

But whatever may be the result of future researches as to the relative age of the ossiferous deposits, or the existence or extinction of the colossal bipeds whose relics are before us, this fact cannot be questioned—the vast preponderance of the class of birds which prevailed (and still prevails) in the fauna of New Zealand, to the almost entire exclusion of mammalia and reptiles. Any palæontologist who saw the entire collection formed by my son alone, could not but feel surprise at its extent and variety. I may venture to affirm that such an assemblage of the fossil bones of birds was never before seen in Europe—nearly one thousand specimens collected from various parts of the country, with scarcely any intermixture of those of any other class: it is a phe-

nomenon as marvelous as the exclusively reptilian character of the fauna of the Wealden epoch. In fact, New Zealand at the present time, as Dr. Dieffenbach observes, offers the most striking instance of an acknowledged fact in every branch of natural history, namely, that different areas of dry land are endowed with peculiar forms of animal and vegetable life; centres or foci of creation, so to speak, of certain organic types. And this organic law, with the effects of which, in the palæozoic and secondary ages, our geological researches have made us familiar, appears to have continued in unabated energy to the present moment. In fact, the most remarkable apparent anomalies in the terrestrial faunas and floras of the secondary epochs are not without modern parallels.

Thus New Zealand, with its peculiar flora, characterized by the predominance of ferns, club-mosses, &c., to the almost entire exclusion of the gramineæ,—and its fauna, comprising but two or three mammals and reptiles,—and the enormous development of the class of birds,—presents a general correspondence with the lands of the carboniferous and triassic epochs.

Australia and Van Diemen's Land possess a flora equally peculiar and extraordinary, and a fauna unlike that of any other part of the world, including some of the most anomalous of existing forms, as for example that marvelous creature the Ornithorhynchus. These countries, in the abundance and variety of the Cycadeacæ, Araucariæ, &c.—in the marsupial character of the great proportion of the mammalia—and in the Terebratulæ and Trigoniæ, and the Cestracionts fishes which swarm in the seas that wash their shores, approximate in their organic relations more nearly to those ancient lands of which the Stonesfield oolites are the debris, than to any of the present regions of the earth.

Lastly, we have a reflected image, as it were, of the "*Age of Reptiles*" of the secondary formations, in the exclusively reptilian character of the quadrupeds of the Galapagos Islands, one species of mouse being the only indigenous mammalian. This Archipelago is a group of volcanic islands situated under the equator, between five and six hundred miles westward of the American coast. "It is," observes Mr. Darwin in his delightful Journal, "a little world within itself; most of the organic productions are aboriginal creations found nowhere else. Seeing every height crowned with its crater, and the boundaries of most of the lava-streams still distinct, we are led to believe that within a period geologically recent, the unbroken ocean was here spread out." These islands swarm with herbivorous marine and terrestrial reptiles allied to the Iguanidæ, which are known in no other part of of the world; and they are as completely distinct from all other existing reptiles, as are the extinct Iguanodon and Hylæosaurus.

The flora too contains more than a hundred plants unknown elsewhere. There is not a fauna or flora in any of the ancient geological periods that presents greater anomalies. Mr. Darwin emphatically remarks, that "when we consider the well-beaten paths made by the thousands of huge tortoises with which these islands are traversed,—the many turtles,—the great warrens of the terrestrial Amblyrhynchi, and the groups of marine species basking on the coast-rocks of every island of this Archipelago,—we must admit that there is no other quarter of the world where the Order of Reptiles replaces the herbivorous mammalia in so extraordinary a manner. The geologist on hearing this will probably refer back his mind to those Secondary Epochs, when saurians, some herbivorous, some carnivorous, and of colossal dimensions, swarmed on the lands and in the seas. It is therefore worthy his especial observation that this Archipelago, instead of possessing a humid climate and a rank vegetation, must be considered as extremely arid, and for an equatorial climate remarkably temperate."*

I have endeavored to express in the annexed table the organic relations between the countries above mentioned and their geological analogues.

MODERN EPOCH.	SECONDARY EPOCHS.
New Zealand. Predominance of Ferns, Lycopodiaceæ and other Cryptogamia. Gigantic Birds. Mammalia absent.	Countries of the Carboniferous and Triassic periods as indicated by fossil remains.
Australia. Cycadeaceous Plants. Marsupial Mammalia.	The lands whence the Stonesfield and Carboniferous oolitic strata were derived.
The Galapagos Islands. Predominance of Reptiles. Herbivorous, terrestrial and marine Saurians and Chelonians.	The country of the Iguanodon, and the regions that supplied the detritus that formed the fluvio-marine secondary strata.

In this point of view the "*Age of Reptiles*" may be considered as merely disclosing an exaggerated effect of the organic law of creation, which imparted to the fauna of the Galapagos Islands its reptilian character. In Australia, and in the Oolitic lands, the mammalian fauna assumed the marsupial type. In New Zealand, and in the Triassic countries, the ornithic vertebrata predominated.

If the ancient philosophers, ere the discoveries of Columbus had opened the New World to the European mind, had found in a fossil state such collocations of the remains of animals and plants as are presented by New Zealand, Australia, and the Galapagos Islands, how impossible would it have been for them, by any

* 'Journal of a Voyage round the World,' chap. xvii.

comparison with existing nature within their circumscribed geographical boundary, to have conceived the possibility of such assemblages of animated beings existing contemporaneously with themselves! In fact, the present geographical distribution of peculiar types of terrestrial animals and plants, affords as many anomalies in the relative predominance of different classes and orders, as are to be found in the vestiges of the earlier ages of our planet.

From these considerations I think we must conclude, that throughout all geological time the changes on the earth's surface, and the appearance and extinction of peculiar types of animals and plants, have been governed by the same physical and organic laws; and that the paroxysmal terrestrial disturbances, though apparently in the earlier ages involving larger areas, and operating with greater energy than the volcanic and subterranean action of modern times, did not affect the established order of organic life upon the surface of the globe; and that throughout the innumerable ages indicated by the sedimentary formations, there was at no period a greater anomaly in the assemblages of certain types of the animal and vegetable kingdoms than exist at the present time.

Additional Remarks on the Geological Position of the Deposits in New Zealand which contain Bones of Birds; by Gideon Algernon Mantell, Esq., LL.D., F.R.S., &c.

Since I had the honor of communicating to the Geological Society a notice of the collection of fossil bones of birds from New Zealand, I have received a letter from Mr. Walter Mantell, dated Wellington, June 18, 1847, containing some details respecting the bone deposits and the strata with which they are associated, which are of considerable interest, and confirm in every essential particular the conclusions suggested in my former communication. The following are extracts from my son's letter:—

"The principal part of the best specimens I have transmitted to you, I obtained from near the embouchure of a stream called Waingongoro, which lies about a mile and a half south of Waimate in the Ngātirú-anúi district. The country hereabout is an elevated table-land, with deep tortuous gullies, through which the torrents and streams take their course to the sea. That of Waingongoro, which is as tortuous as any of them, appears to rise in Mount Egmont (the volcanic ridge which is 9000 feet high); indeed it must have its source there, or in the short chain of hills which lies between that mountain and the coast in a westerly direction; for in returning to New Plymouth by the mountain-road—a forest-track at the back of the volcanic ridge—I must have crossed it, did it rise elsewhere. The Waingongoro evidently discharged itself at some distant period into the sea, far from its present embouchure, as is proved by the existence of a line of cliffs which

extends inland, and has clearly been produced by the eroding action of the river. Driven from its course, probably by a change in the relative level of the land and sea, it has formed its present channel, which cuts through a hundred feet of loose conglomerate, overlying a bed of finely laminated sand, and containing wood in a very recent state,—so recent as to bear cutting with a knife.

"The conglomerate is composed of an infinite variety of volcanic rocks, with numerous immense rounded masses of the same kind. The clay abounds in marine shells, all of existing species (?); the upper layers contain but few shells, but the lowermost abound in them, and they are in a perfect state—not drifted shells. In a stratum of sand at Wanganui the shells of a sandy bottomed sea are found, with some fragments of large Nautili.

"Between Takikau and Ohawetokotoko there is a wide flat of undulating sand, about two hundred yards across. On my first visit the surface was covered with bones of men, moas and seals, &c., which had been overhauled by the Rev. R. Taylor. I had some deep openings made near the base of the ancient cliffs, under the Pa Ohawe; and at the same level as that on which were the strewn fragments of bones I have mentioned, I came to the regular bone-deposit. The bones were mostly perfect in shape, but so soft, that if grasped strongly they would change, as if by magic, into clay. Unfortunately the natives soon caught sight of my operations, and came down the shoals, trampling on the bones I had carefully extracted and lain out to dry. My patience was tried to the utmost, and to avoid blows I was obliged to retreat and leave them in full possession of the field; and to digging they went in right earnest, and quickly made sad havoc. No sooner was a bone perceived than a dozen pounced upon it, and began scratching away the sand as if for their lives; and the bone was of course smashed to pieces. I am only surprised that I ultimately succeeded in getting any entire.

"The natives affirm that this sand-flat to Rangatapu was one of the places first dwelt upon by their ancestors; and this seems not unlikely, for in digging in various places I found small circular beds of ashes and charcoal and bones, very ancient, and such as are generally left by the native fires that have been long lighted in the same spot. Fragments of obsidian, native flint, two fishing-line stones and a whalebone *meri* (a sort of weapon) were also dug up. The natives told me, and their assertion was borne out by the appearance of the place, that within their memory the entire area had been covered by drift-sand; in fact, the bones seemed always to be imbedded on or beneath an old surface-level. Columns of vertebræ when uncovered were lying *in situ* and perfect, with, in rare instances, skull and pelvis; but to preserve these precious relics was impossible while beset with the hordes of natives; and I could not drive or bribe them away.

"The largest femur, tibia and fibula were lying in their natural connection—the leg slightly bent at the knee; a chain of vertebræ of the largest size was discovered near them, and I doubt not the whole belonged to the same colossal bird. You will readily imagine how exasperating it was to me to see specimen after specimen destroyed before my eyes, with no possibiliy of preventing it. From your ignorance

of the excessive obstinacy and mulishness of the natives, I fear your indignation will be directed against me; but if so, let me assure you, you are indeed in error. All that man could do I did to dissuade them from turning oryctologists or palæornithists; but to no purpose. Men, women and children resolutely dashed at every bone that appeared when the sand was removed; and if they listened for a moment to my entreaties and remonstrances, it was but to return with renewed vigor to the work of destruction.

"Mixed with the bones, but exceedingly rare, were the fragments of egg-shells, of which I sent you my then best specimens by post last April. I have also found six oval rings and one broad circular ring of the trachea. In coming down from Ngamotu I discovered a few more remains of eggs; one fragment is four inches long, and gives a good chord by which to estimate the size of the original: as a rough guess, I may say that a common hat would have served as an egg-cup for it: what a loss for the breakfast-table! And if native traditions are worthy of credit, the ladies have cause to mourn the extinction (?) of the Dinornis: the long feathers of its crest were by their remote ancestors prized above all other ornaments; those of the white crane, which now bear the highest value, were mere pigeons' feathers in comparison."

I have given these extracts without correction or comment, as they were written by my son for my private information, that I might not weaken the graphic description of the exhumation of the bones exhibited and described at the last meeting of the Society. There are still some details required to render it certain that the bone-bed is always intercalated, when not laid bare by modern denuding causes, between the blue clay with recent marine shells and the conglomerate of volcanic pebbles and boulders which forms a bed of from fifty to a hundred feet thick; but so far as I can interpret my son's meaning, and upon comparison of his statements with those of Mr. Colenso and others, I conclude that such is its true geological position. There is also some doubt whether in the heaps of ancient native fires which contain bones of man, dog, and moa, those of the colossal birds may not have been introduced by accident, and their charred appearance have been occasioned by drying, from exposure to the air and sun; but it must be remarked that these specimens never contain any of the sand in which they were imbedded, as the other examples do. These and other points will, I doubt not, be satisfactorily elucidated ere long, now that the collecting of the bones of the extinct birds of New Zealand is so earnestly and systematically pursued. In the meanwhile, the imperfect and hasty sketches of my son which I have placed before the Society, will not, I trust, be deemed altogether unworthy attention.

19, Chester Square, Pimlico.

Art. IV.—*Parallelism of the Palæozoic Formations of North America, with those of Europe;* by Ed. de Verneuil.

(Continued from pp. 183, and 370, vol. v.)

Carboniferous System.—Of all the principal divisions of which the palæozoic formation in America is composed, the Carboniferous system is that which is best defined, and has the most characters in common with European deposits of the same age.* It includes two or three stages, according as it is considered in the eastern or western states of the Union. It commences below by a micaceous psammite which so much resembles the rocks of the Portage [Chemung] group, that they have been completely assimilated.† The geologists who have attempted to show the parallelism of the American formations with those of Europe, have thus referred to the Devonian system those sandstones so well known in the states of Ohio and Indiana under the name of fine-grained sandstone, or Waverly series. The examinations which we have made to the south of Cleveland, in the state of Ohio, the fossils which we have found near Medina,‡ Cuyahoga and Newark, Ohio, have convinced us that a great part of these sandstones belong really to the Carboniferous system. The lower beds only may represent the Devonian stage of Portage, but as the rocks of this group completely resemble those which we unite with the Carboniferous system, and as in the state of Ohio they do not contain fossils, it will be understood that it is almost impossible to distinguish, in the sandstones of Waverly, those which are the prolongation of the beds of Portage from those which incontestibly belong to the Carboniferous system.§

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* In the different parts of America through which we have travelled, we have always readily distinguished it by its fossils, and have verified the truth of what we said seven years since, upon the importance of the limit which separates it from the lower formations. (Bull. de la Soc. Geol., vol. xi, p. 166.)

† We have brought from Cuyahoga and from Medina, Ohio, psammites with *Productus*, which it is almost impossible to distinguish mineralogically from specimens found at the Falls of Portage, N. Y.

‡ We are indebted to our colleague, Mr. W. C. Redfield, for directions in finding fossils at this locality.

§ [It appears to us that here is an admission somewhat at variance with the proposition at the commencement of the article. If the Carboniferous System is so well defined and characterized, there is no need of questioning the line of demarkation between the Portage and Chemung group, which are of admitted Devonian age, and the Carboniferous sandstones. The truth, however, is, that there is no well defined line of separation between the Chemung rocks of New York and the sandstones of Ohio and Indiana, which contain Carboniferous fossils. The error of American geologists, who have attempted to compare our formations with those of Europe, has been in this instance that of regarding the great carboniferous limestone as forming the basis of that system, including all the strata below in Devonian and Silurian. We have, in fact, been looking for great lithological changes and topographical features at the limits between two great systems, but as they are now divided, these great features are more frequently observed in the midst of a system than at its termination or commencement.—James Hall.]

If in Ohio, at the base of what is called the fine-grained or Waverly sandstones, there exists some representation of the Devonian beds, it is no longer so farther west. In the states of Indiana, Kentucky and Tennessee, the Carboniferous system comprises all the micaceous sandstones as far as the black slates, their lower beds including true Carboniferous species, such as the *Spirifer striatus*, *Productus punctatus*, &c.* In Tennessee a very abundant siliceous matter appears to have penetrated the sandstones, and sometimes to have converted them into chert, or a species of millstone (buhrstone) grit. These are the siliceous strata of Prof. Troost, so important under an economical point of view, from the quantity of iron which they contain. These beds are sometimes filled with encrinites and corals, mingled with a small number of shells, characteristic of the Carboniferous System. The psammites and the siliceous beds which we thus unite with the Carboniferous system, are of great thickness, and cover a considerable extent of country, so that the change which we propose will bring other important changes in a map of the United States, colored according to the European classification, such for example as that of Mr. Lyell.†

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* Mr. Hall, in his memoir upon the identity of the Western formations with those of New York, calls sub-carboniferous only the upper part of these psammites. (*a*)

(*a*) [I have not been so fortunate as to find fossils within two hundred feet above the black slates, although they are abundant at a greater elevation. The lower portion of these slates and sandstones in the vicinity of New Albany, Ia., have so great a resemblance to the rocks of the Portage and Chemung groups, that I could not forbear referring them to that period, while the more friable and micaceous sandstones above containing fossils of true carboniferous types, I called sub-carboniferous, from the fact that up to that time I was not aware that anything below the base of the great carboniferous limestone had been recognized as belonging to the carboniferous period.

It will be recollected that there is a thickness of more than five hundred feet between the top of the black slates and the base of the limestone.—(*Transactions of Am. Association of Geologists and Naturalists*, vol. i, p. 281.) This, if admitted to belong entirely to the Carboniferous system, is an immense addition to its thickness. On the other hand it must be recollected that this series holds the place of the Portage and Chemung groups, which can be clearly traced into Ohio, still holding a great thickness, and it seems scarcely possible that it can have entirely disappeared in so short a space, while a subsequent deposit has extended to Medina and Cuyahoga, in the eastern part of that state.

Were this the proper occasion, we might go on to show how the Chemung group of central and Western New York is more nearly related to the Carboniferous sandstones of the West than to the Hamilton group of Eastern New York.—J. H.]

† Our view has been adopted by Dr. Dale Owen, who has written to us, that since our travels in these countries he has had an opportunity to verify the truth of it in Kentucky, where he has recognized that in fact all the beds above the black slates belong to the Carboniferous system. This slate furnishes then a very constant horizon to distinguish the Carboniferous system from the lower deposits. (*b*)

(*b*) [We have no disposition to find fault with the reasoning of M. de Verneuil, or with the facts which he brings to sustain his views, but a careful study of the preceding pages clearly proves that no one point is yet established, and that the line of separation between the carboniferous and lower deposits is far from being

In Europe this stage is probably represented by the yellow sandstones of Ireland, and by slates and sandstones which we have seen in Westphalia, north of Hagen, and which have been described by Messrs. Sedgwick and Murchison. (Geol. Trans., vol. v.)

Above the psammites, or the siliceous strata, comes the carboniferous limestone, which is exactly the equivalent of that of Europe, and which contains its most characteristic fossils.

The third stage of the Carboniferous system is formed by the sandstones and coal shales which surmount the preceding limestone. Aside from their extent and their unexampled thickness, they appear to be the representative of the coal deposits of Europe. They contain, in fact, nearly the same plants, but they are distinguished, nevertheless, by their marine origin, or at least by their alternation with limestones filled with marine fossils. These limestones, whose thickness is insignificant compared with that of the whole of the coal series, are of great importance in the theory of the formation of coal. Their fossils are nearly the same as those of the carboniferous limestone.* The coal schists themselves contain very few fossil shells. Nevertheless, near Blossburgh, in Pennsylvania, and in Maryland, are found certain species analogous to those of the environs of Glasgow, in Scotland, such as *Euomphalus carbonarius*, *Bellerophon Urii*, *Machrocheilus curvilineus*, *Allorisma sulcata*, and some very rare bivalves resembling the Uniones.

Let us now pass in review the list of species common to the two continents, and rapidly indicate the parallel modifications which they present. According to our own observation, this list is composed as follows. *Phillipsia seminifera*, *Orthoceratites calamus*, *Goniatites rotatorius*, *Nautilus tuberculatus*, *Bellerophon*

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well defined. All our attempts to limit *systems*, where the whole is *one* great system, must fail in their application, and the facts in this case prove conclusively, that the line of separation between Carboniferous and Devonian is not yet so well defined as that between Devonian and Silurian, or even between the lower and upper divisions of the latter system.—J. H.]

* [We would ask, what is understood here by nearly the same? (à peu près les mèmes.) The fossils of these intercalated beds of limestone are generically identical with those of the great carboniferous limestone, but are they specifically identical or absolutely different? Have the *Spirifer attenuatus*, and *Terebratula Royisii*, and some others known in these thin beds of limestone in Ohio, ever been seen in the great carboniferous limestone below? For ourselves we are obliged to confess, that we have never had the good fortune to see them in the latter position in all the localities we have visited. We cannot, moreover, for other reasons, feel willing to admit that the same fauna which flourished during the deposition of the great carboniferous limestone, reappeared at intervals after the commencement of the deposition of the coal shales and sandstones, with plants indicating the existence of dry land and fresh water. All the species we have collected from these intercalated beds of limestone in the coal measures of Ohio, though of marine origin, are specifically distinct from any we have seen from the limestone below.—J. H.]

hiulcus, B. Urii, Euomphalus carbonarius, E. pentangulatus, Macrocheilus curvilineus, Allorisma sulcata, Terebratula Roissyi, T. planosulcata, Spirifer lineatus, S. striatus, S. attenuatus, S. cuspidatus, Orthis crenistria, O. resupinata, O. Michelini, Leptæna depressa, Chonetes sarcinulata, Productus semireticulatus, P. Cora, P. Flemingi, P. punctatus, P. costatus, Cidarites Nerii, Amplexus spinosus, Cyathophyllum mitratum, Chætetes capillaris, Fusulina cylindrica; total, thirty-one.

All these species, except the *Leptæna depressa*, and the *Orthis crenistria*, are peculiar to the Carboniferous system, and characterize it over a great part of the globe; for by a remarkable exception, many species of this system have at the same time circumscribed vertical limits and very extensive horizontal distribution: such are for example the *Productus semireticulatus, P. Cora*, and *P. Flemingi*, which have been found from the Altai and the Russo-Chinese frontiers to Missouri, and even upon the plateau of the Andes of Bolivia.

When we compare the carboniferous fauna of America with that of Europe, we see with astonishment, that notwithstanding the distance which separates these countries, the genera and the species present the same modifications, the same differences from the preceding fauna.*

In fact, while the persevering researches of Mr. King, in Pennsylvania,† go to prove to us the existence of large air-breathing animals at this epoch, the discovery of a Saurian recently made in the carboniferous beds in Germany,‡ proves that the appearance of this class of animals, more ancient than has been believed until now, was contemporaneous on the two continents.

The trilobites follow a similar order of decrease, and are reduced in America as in Europe, to some small species of the genus Phillipsia. The Goniatites offer also for the first time the new

* The analogy between the two continents appears to be more marked at this epoch than at the anterior epochs, the number of identical species being relatively more considerable. If we seek the cause of this, we are led to attribute it to more analogous physical conditions, which proves the uniformity of the deposits of this epoch, and perhaps also to a peculiar disposition of the submarine outline, that is to say, the bottom and the islands which extended from Europe towards America. M. Élie de Beaumont explains this disposition in a very natural manner. He regards it as an effect of the W.N.W. upheaving which preceded the establishment of the Carboniferous system, and which he has called the system du Ballon of the Alsace. We are happy to see the beautiful theory of our illustrious friend thus confirmed by independent researches.

† See the interesting letter of Mr. Lyell upon the evidence of the footprints of a quadruped resembling the Cheirotherium, in the Carboniferous strata of Pennsylvania. (This Journal, ii ser., vol. ii, p. 25.)

‡ This discovery, of which we have been informed by von Buch, destroys the principal objection which could be made to the extent which we have given to the Palæozoic formation, in our work on Russia, by comprising in it the Permian System; for this objection was founded on the opinion then established, that the Saurians appeared for the first time in this system; and the importance of the appearance of animals of this class to determine the point of departure of the secondary formation.

type when the dorsal lobe, instead of being simple, is divided by a small medial saddle.

The distribution of the Productus, offers another remarkable coincidence. Unknown in America in the Silurian system, appearing under one or two small forms in the Devonian epoch, the species assume in the carboniferous rocks a development altogether in harmony with the facts observed in Europe. The Spirifers of this epoch present also in America the character of having the plications often dichotomous, which M. d'Archiac has already indicated in Europe,* and by which they are distinguished from those of the Devonian epoch, which have them always simple.†

As to the Terebratulæ, we will mention the interesting fact of the simultaneous disappearance of two species, the *T. reticularis* and *T. aspera*, which, during the Devonian and upper Silurian epochs, were spread with great profusion from the Altai and Ural to the Missouri. We will cite also, as simultaneous phenomena upon the two continents, the appearance of those Crinoids forming a passage to the echinoderms, such as the *Palæechinus* or *Melonites*, the extinction of those great corals, such as the *Favosites Gothlandica*, *Porites interstincta*, &c., and their replacement by the *Chætetes* and *Lithostrotion*, nearly identical in Europe and in America. The analogy between the two continents continues even to the Foraminifera and the plants. We have seen indeed that the *Fusulina cylindrica*, so characteristic of the carboniferous limestone of Russia, occurs in the cherts or siliceous beds of the coal sandstones of Ohio. And as to plants, the immense quantity of terrestrial species identical on the two sides of the Atlantic, proves that the coal was formed in the neighborhood of lands already emerged, and placed in similar physical conditions.

With the Carboniferous system terminates the palæozoic formation in North America. During all the time of its deposition, the surface was free from great disturbances.‡ Slow and insensible oscillations had caused to emerge areas more or less circular of the submarine surface where the Silurian and Devonian deposits were made, and had contracted the limits of carboniferous deposits; but the horizontality of the beds was not disturbed. It is only after the carboniferous epoch that an energetic force,

* Memoir on the Palæoz. Foss. (Trans. Geol., vol. v, page 319.) See also Geology of Russia in Europe, vol. ii, p. 126. Von Buch, in his interesting memoir which he has published upon Cherry Island (*Bären insel*), has insisted with reason, on the importance of this character which might be thought insignificant.

† It is also only at the Devonian epoch that we find the Spirifers in which the back is divided by a slight furrow, as in *S. mucronatus* and *Bouchoidi*.

‡ In the eastern part of the United States, where the palæozoic formation is much disturbed and metamorphosed, Mr. H. D. Rogers believes he is able to recognize traces of dislocations, which have broken up the strata after the epoch of the Hudson River or Clinton Group. (This Journal, ii ser., vol. i, p. 411.)

folding and raising the terrestrial crust, gave birth to the chain of the Alleghanies. The manner in which the plications, largely undulated at first, contract, multiply and fold over in going from northwest to southeast, towards the metamorphic and granitic rocks, situated most frequently beyond the chain, properly so called, has been perfectly elucidated by the two Professors Rogers.*

It does not enter into our design further to extend this notice; having fulfilled, according to our ability, the end which we proposed, to establish a parallel between the palæozoic formations of North America and Europe. Permit us, in conclusion, to present a resumé of the course we have followed, and the principal results at which we have arrived.

In order to make fully understood the interest and importance of this parallelism, and the light which it throws upon the knowledge of palæozoic deposits in general, we have shown the advantageous geological conditions of North America, and how, owing to the horizontality of the beds over great extent of surface, to their concordant and uninterrupted superposition, it is possible to arrive at an absolute certainty as to the duration of species, that is to say, the point in the series where they first appear and where they become extinct.

In order to compare North America with Europe, it has been necessary for us to give a rapid glance at the groups and stages of which the palæozoic formation is there composed. The differences which are presented to us in the geognostic conditions of the state of New York and the Western States, such as Ohio and Indiana, have revealed to us the degree of importance which it is necessary to attach to these different groups. We have seen that their number, variable according to their vicinity or distance from lands emerged at the epoch of their formation, had little importance as regards the establishment of systems founded upon palæontological characters. We have seen also, that in general, the limestones are more constant than the shaly or arenaceous beds, that they form more extensive horizons, and furnish a surer guide to the geologist.†

Passing afterwards to a comparison of the two continents, we have shown, supporting our views by geological analysis, how the American substages should be grouped to correspond with the Silurian, Devonian and Carboniferous systems of Europe. We have not disguised the fact that the divisions introduced upon

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* On the Physical Structure of the Appalachian Chain as exemplifying the laws which have regulated the elevation of great mountain chains generally, by W. B. and H. D. Rogers.

† M. C. Prevost, in his memoir upon the synchronism of formations, (Comptes Rendus, April, 1845,) has clearly shown the importance of the pelagic calcareous deposits as compared with the arenaceous beds formed under the influences of coasts.

this principle did not correspond, in certain countries, with the divisions indicated by the mineralogical character of the rocks; thus the limit between the two stages of the Silurian system, very well marked in the state of New York, is observed near the Mississippi in consequence of the predominance of magnesian limestone; it is the same with the Silurian and Devonian systems, the limit between which is found in the upper part of the great calcareous formation called cliff limestone; as well also as with the Carboniferous system, in parts of the state of Ohio, where it is in contact with the Devonian psammites of Portage.

These mineralogical transitions, which one would expect in a country free from disturbances, would not, however, obscure the proofs of a parallel development of the animal kingdom in the two continents; for if, leaving aside the difficulties of fixing the limits between the systems, we compare the systems together, or still better, one by one the groups of which they are composed, we acquire the conviction that identical species have lived at the same epoch in America and in Europe, that they have had nearly the same duration, and that they succeeded each other in the same order. We have endeavored to prove that the first traces of organic life in countries the most remote, appear under forms nearly alike, at the base of the Silurian system; and that the same types, often the same species, are successively and in parallel order, developed throughout the entire series of the palæozoic beds. If we have not succeeded in lifting the veil which still hides from us the cause of this grand phenomenon, perhaps at least our observations demonstrate the insufficiency of those causes by which certain authors seek to explain it. They prove in effect that the phenomenon itself is independent of the influences which the depths of seas* exercise upon the distribution of animals: for if, in certain countries, the Silurian deposits prove a deep sea, they have on the contrary in the state of New York, a littoral character. They prove in fine, that in its general character it is equally independent of the upheavings which have affected the surface of the globe; for from the eastern frontier of Russia even to Missouri, distant from or near the lines of dislocation, in the horizontal beds as well as in those which are disturbed, the law according to which it is accomplished appears to be uniform.

(To be continued.)

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* We do not pretend to say that the differences of depth in the seas had not already an influence upon the distribution of animals; it is to this circumstance, on the contrary, that we attribute the more or less local fauna which we often discover in the palæozoic formation. But these local faunæ always afford some species which connect them with the epoch to which they belong. They are the exceptions (*hors d'œuvre*) which do not derange the general symmetry.

ART. V.—*The Dodo and its Kindred, or the History, Affinities and Osteology of the Dodo, Solitaire and other extinct Birds of the Islands Mauritius, Rodriguez, and Bourbon;* by H. E. STRICKLAND, and A. G. MELVILLE.*

THIS beautiful volume is illustrated by fifteen quarto and folded plates, containing one hundred and fifty figures chiefly lithographs; some are executed by the anastatic process—and three by a new process called Papyrography.

Part I. of this work, containing seventy pages, was written by Mr. Strickland, and comprises the historical and descriptive portions; Part II. (pp. 56) is by Dr. Melville, and includes the Osteology.

This is a very remarkable Book. The historical facts have been gathered with great industry from nearly one hundred and fifty works cited, and most of them consulted by the author, and they have been combined with signal skill and acuteness.

The singular birds of which the volume treats, peopled in great numbers the Islands Mauritius, Bourbon and Rodriguez, until nearly two centuries since, when they were exterminated by the hand of man. Their extinction is therefore not to be ascribed, like that of many races, to the agency of geological causes. Man, especially in the earlier colonial and savage state, indulges in the slaughter of the inferior animals—too often from the mere pleasure of destroying them even when their bodies are not subservient to his wants.

Mr. Strickland remarks, however, in the introduction—that "it appears highly probable that death is a law of nature in the species as well as in the individual; but this internal tendency to extinction is in both cases liable to be anticipated by violent or accidental causes. The object of the treatise is to exhibit some remarkable examples of the extinction, through human agency, and under circumstances of peculiar interest, of several ornithic species, constituting an entire sub-family." Mr. Strickland observes that the geographical distribution of organic groups is equally remarkable with their geological succession in time; certain groups of both animals and plants, often containing numerous genera and species, being found to be confined to certain continents and their circumjacent islands.

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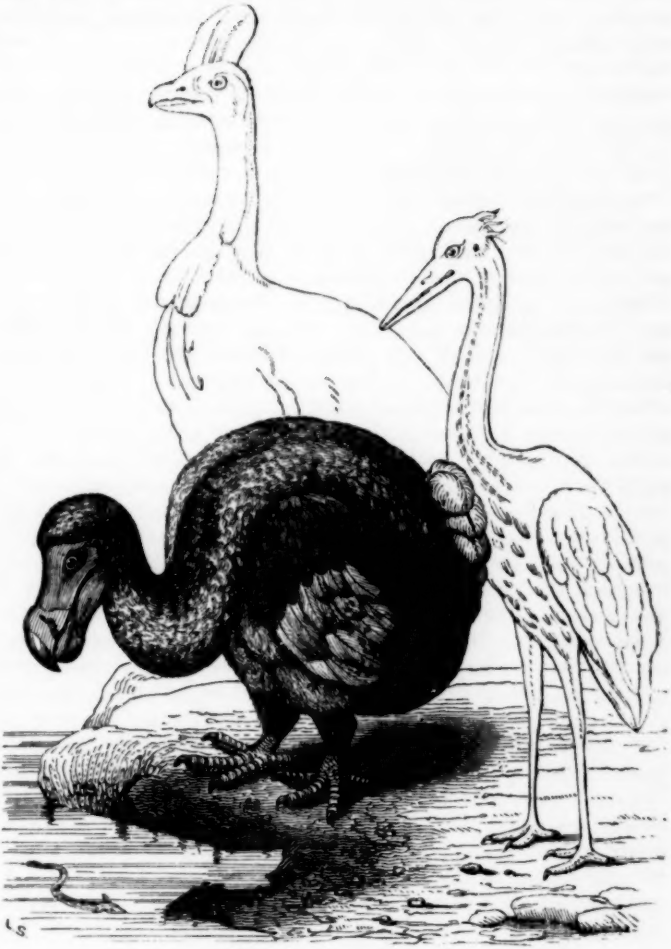
* The Dodo and its kindred, or the history, affinities and Osteology of the Dodo, Solitaire and other extinct birds of the Islands Mauritius, Rodriguez, and Bourbon. By H. E. STRICKLAND, M.A., F.G.S., F.R.G.S., *President of the Ashmolean Society*, &c., and A. G. MELVILLE, M.D., Edin., M.R.C.S., "PES et CAPUT uni reddentur formæ." London: Reeve, Benham and Reeve, 8 King William street, Strand. 1848. Quarto, pp. 141. Dedicated to P. B. Duncan, Esq., M.A., Keeper of the Ashmolean Museum.



The Dodo, with the Solitaire in the background.—Fac-simile of Roland Savery's picture of the Dodo, dated 1628, now in the Bellvedere at Vienna.

Detached islets, like the Galapagos, for instance, are often inhabited by terrestrial forms allied to those of the nearest continent although hundreds of miles distant, and evidently never connected with them; analogous beings having been introduced without making a violent break in the system of nature. The three small volcanic islands whose ancient birds form the subject of the present volume, although placed at considerable distances apart, are still nearer to each other than to any contiguous land. They lie in the Indian Ocean east of Madagascar. A few of their indigenous plants and animals are either allied to, or identical with, the products of Africa;—the larger number resemble those of Madagascar; while certain species are confined to the islands themselves, especially a peculiar group of birds, specifically distinct in each island, yet allied in their general characters, and remarkably isolated from any known forms in the world. "These birds were of large size and grotesque proportions, the wings too short and feeble for flight, the plumage loose and decomposed and the general aspect suggestive of gigantic immaturity." "The civil history of these birds, if we may so speak, is as remarkable as their organization. About two centuries ago, their native isles were first colonized by man, by whom these strange creatures were speedily exterminated"—and "so rapidly, that the vague descriptions of early navigators were long regarded as fabulous or greatly exaggerated, and these birds, almost cotemporary with our great grandfathers, became associated in the minds of many persons with the Griffin and the Phœnix of mythological antiquity." "The object of the present work is to vindicate the honesty of the rude voyagers of the seventeenth century—to concentrate the evidence—to describe the few remains—to excite farther inquiry, and fix the rank of these birds in the system of nature."

These birds technically called the *Didinæ*, "furnish the first clearly attested instance of the extinction of an organic species through human agency, although other instances have occurred both before and since,* and many species of animals and plants are now dying away under the advance of human population."

In the case of the Didinæ our only sources of information are the rude narratives of unscientific voyagers, a few oil paintings and a few scattered osseous fragments, which have survived the

* For example, the Irish Elk—*Cervus megaceros*, and the *Bos primigenius*, or Urus, destroyed in ancient, and the Dugong in modern times. The Aurochs or *Bison priscus* is even now preserved only by imperial protection in the Bialowiksa forest in Russia, and the Czar Nicholas has lately presented a living pair to the Zoological Gardens of London. The *Nestor productus*—a parrot of Phillip's Island near Norfolk Island, is now extinct; and the few surviving individuals confined in cages refuse to breed. There is also a burrowing parrot, *Strigops habroptilus*, from New Zealand, and there are still surviving two or perhaps three species of *Apteryx*.

neglect of two hundred years. In many cases there exist better data for determining a species which perished ages ago by geological causes, than in the case of a group of birds, several species of which were living in the reign of Charles the first of England.

Historical notices of the Dodo.—This strange abnormal bird, according to undoubted evidence, formerly existed in great numbers in the Isle of Mauritius. The evidence is *historical, pictorial* and *real.*

Although it is asserted that Mauritius was discovered early in the sixteenth century, nothing definite was known of it until the close of that century, when the Dutch navigator Van Neck took possession of it, as it was uninhabited, and called it Mauritius.

The author has copied a quaint old print of Van Neck, exhibiting the ship's company reveling in the virgin profusion of the island. Birds, fishes, fruits, tortoises, bats and paroquets, among animals, and Dates and other Palm trees among plants, with the men at their labors, are all exhibited in a grotesque form, animated and graphic, but with wild violations of proportion and perspective.

Clusius, a Dutch writer—1605—gives a figure of the Dodo, and states that stones an inch in length were found in the gizzards of this bird, which were as large as in the swan but very different in form.

In 1602, Admiral Schuurmans staid some time at Mauritius, and frequently mentions the Dod-aarsen or Dodos, on which the seamen reveled—three or four of these birds, and in one instance two, weighing probably fifty pounds each, having furnished an abundant meal for a ship's crew. They are described as having great heads with hoods thereon, with round sterns, without wings or tail, and with only winglets on their sides and four or five feathers behind; and as carrying commonly in the stomach a stone the size of a fist. The sailors sometimes caught fifty birds in a day, half of which were Dodos. Their historian has recorded their doings in homely verse, which is thus "Englished" by our author.

> "For food the seamen hunt the flesh of feathered fowl,
> They tap the Palms, the round sterned Dodos they destroy,
> The Parrot's life they spare that he may scream and howl
> And thus his fellows to imprisonment decoy."

In 1605, Clusius saw at Leyden a Dodo's leg; the tarsus over four inches long and nearly four in circumference, covered with thick yellowish scales. The toes were about two inches and the nails about one inch long.

The birds are mentioned again at Mauritius in 1606 by Cornelius Matelief, a Dutch admiral, and in 1607 the crews of Van der Hagen feasted on *Dodars* and other game, and they salted Dodars and tortoises for consumption on the voyage.

In 1607, the crews of Van der Hagen's two ships "feasted on abundance of tortoises, dodars, pigeons, turtles, grey parroquets and other game," which they caught by hand in the woods, and they salted quantities of *dodars* and tortoises for their voyage.

In 1611, P. W. Verhuffen touched at Mauritius, and mentions *Dodos* under the name of *Totersten*. He describes them as Van Neck had done;—says that his sailors killed numbers of them daily for food, and that the Dodos sometimes inflicted severe wounds upon their aggressors with their powerful beaks.

In 1617, Picter Van den Broecke visited Mauritius, and in the account of his voyages there is a rude figure of the Dodo and also of a short winged bird resembling the Apteryx, but neither of the figures is alluded to in the book.

Sir Thomas Herbert was at Mauritius in 1627, and has given a figure of the Dodo and a description, of which the language was varied in other successive editions. All these descriptions are amusing on account of their quaintness; the following is the most recent; "The Dodo: a bird the Dutch call Walghvogel or Dod Eersen; her body is round and flat, which occasions the slow pace, or that her corpulencie; and so great that few of them weigh less than fifty pounds; meat it is with some, but better to the eye than stomach; such as only a strong appetite can vanquish; but otherwise, through its oyliness it cannot chuse but quickly cloy and nauseate the stomach, being indeed more pleasurable to look than feed upon. It is of a melancholy visage as sensible of natures injury in framing so massie a body, to be directed by complementary wings, such indeed as are unable to hoise her from the ground, serving only to rank her amongst birds; her head is variously drest, for one half is hooded with down of a dark color; the other half naked and of a white hue, as if lawn were drawn over it; her bill hooks and bends downwards; the thrill or breathing place is in the midst; from which part to the end, the color is of a light green mixt with a pale yellow; her eyes are round and bright (her eyes are small, and like to diamonds round and rowling);* and instead of feathers has a most fine down; her train (like to a *Chyna* beard) is no more than three or four short feathers; her legs are thick and black; her talions great; her stomach fiery, so as she can easily digest stones (stones and iron); in that and shape not a little resembling the Ostrich."

François Cauche says, that in 1638, he saw in Mauritius birds "larger than a swan, covered with a black down, with curled feathers on the rump, and similar ones in place of wings; that the beak was large and curved, the legs scaly, the nest made of herbs heaped together, that they lay but one egg of the size of

* The clauses here in parentheses are from one of the other descriptions of the same author.

a half penny roll or of that of a Pelican, and that the young ones have a stone in the gizzard."

Sir Hamon Lestrange, father of the more celebrated Sir Roger, relates, thus: "About 1638, as I walked London streets, I saw the picture of a strange fowle hung out upon a cloth, and myselfe with one or two more then in company went in to see it. It was kept in a chamber, and was a great fowle, somewhat bigger than the largest Turky Cock, and so legged and footed, but stouter and thicker and of a more erect shape, colored before like the breast of a young Fesan, and on the back of dun or deare color. The keeper called it a Dodo, and in the end of a chymney in the chamber there lay a heape of large pebble stones, whereof hee gave it many in our sight, some as bigg as nutmegs, and the keeper told us shee eats them, (conducing to digestion,) and though I remember not how farr the keeper was questioned therein, yet I am confident that afterwards shee cast them all againe."

Thus it appears that a living Dodo was exhibited in London, more that two hundred years ago.

In Piso's edition of Bontius, 1658, there is a description of the Dodo, with a figure, being the earliest copy from one of Savery's paintings. The bird is described as between the ostrich and turkey. Its legs are short, with four toes, stout, long, scaly, and the claws strong and black—the head large and clumsy, and covered with a membrane like a hood. The eyes are large and black; the neck curved, prominent and fat; the beak remarkably long and strong—the gape hideous—enormously wide, as though formed for gluttony. The body is fat, round and clothed with grey feathers, in the manner of ostriches; in place of quills are small grey feathered wings, and in place of a tail, fine curved plumes of the same color. The bird is slow and stupid, and easily taken by the hunters. The flesh, especially that of the breast, is fat and eatable, unless when it is old or not well boiled. Three or four have sometimes sufficed to feed a hundred seamen. They swallow pebbles and all sorts of hard substances without digesting them.

Captain Wm. Talbot, of the ship Berkley Castle, was in Mauritius in 1679, and the journal of his mate, Benjn. Harry, mentions, among the productions of the island, *Dodos, whose flesh is very hard.* This is the most recent account of the existence of Dodos in Mauritius.

The above is a condensed abstract from Mr. Strickland's work, of the historical evidence regarding the existence of the Dodo. In 1644, the Dutch began to colonize Mauritius, and these noble birds were so speedily destroyed by the thoughtless rapacity of the colonists—aided by their companions, dogs, cats and mice, which eagerly devoured the eggs of the Dodo—that they are not even mentioned by Leguat among the productions of the island.

After the French took possession of the country, in 1712, under the name of the Isle of France, we hear no more of the Dodo among living beings.

Specimens and remains of the Dodo.—In Tradescant's catalogue of his museum, in South Lambeth, near London, there is this entry:

"Dodar from the island of Mauritius; it is not able to flie, being so big."

This was an entire bird; it was probably the same that was seen alive by Lestrange, in 1638; it was seen entire by Willughby, whose Ornithologia was published in 1676, and the specimen is alluded to by others. It passed with the rest of Tradescant's collections into the Ashmolean Museum, at Oxford, where the head and foot are still remaining. These belonged to a stuffed specimen of Tradescant, which was bequeathed with the rest of his curiosities to Elias Ashmole, the munificent founder of the Ashmolean Museum, at Oxford. There it remained entire for a century, until 1755, when the vice-chancellor and the other trustees, came in an unlucky hour to make their annual visit to the museum. Zoology had then no legal existence as a science taught in the University; the specimen of the Dodo had become decayed by time and neglect, and was ordered by the visitors to be removed. On this fatal decree Mr. Lyell remarks: "Some have complained that inscriptions on tomb-stones convey no general information, except that individuals were born and died—accidents which happen alike to all men. But the death of a species is so remarkable an event in natural history, that it deserves commemoration; and it is with no small interest that we learn from the archives of the University of Oxford, the exact day and year when the remains of the last specimen of the Dodo, which had been permitted to rot in the Ashmolean Museum, were cast away. The relics, we are told, were "a Museo subducta, annuentibus Vice-cancellario aliisque Curatoribus, ad ea lustranda convocatis—die Januarii 8vo, A. D. 1755."

By a lucky accident, the head and one of the feet of the last descendant of an ancient race escaped destruction from the flames, and are still in the Ashmolean Museum. The head is in tolerable preservation, with the peculiar beak and nostrils, the bare skin of the face, and the partially feathered occiput, formerly compared to a hood. The eyes still remain dried within the sockets, but the corneous extremity of the beak has perished; the specimen was probably a female. This head has been of late carefully dissected down on one side so as to expose its osteological structure.

A leg, or rather foot, of the Dodo, belonging to a larger individual than that mentioned above, is still preserved in good con-

dition in the British Museum; it exhibits the external characters of the tarsus and the toes in a very interesting manner.

A cranium, mentioned by Olearius as being in 1666 in the Gottorf Museum, at Copenhagen, after being neglected for almost two centuries, was lately "recovered by Prof. C. Reinhardt from a heap of venerable rubbish." It corresponds very nearly with the Oxford specimen, but all the soft parts are removed.

These are all the known genuine fragments of the Dodo, but it is hoped that others may be yet discovered in the island of Mauritius, by researches about to be undertaken there.

Pictures of the Dodo.—In addition to the rude drawings of the early voyagers, all of which, with a single exception, are marked by strong verisimilitude, there are five oil paintings by eminent artists, which leave no reasonable doubt of their being faithful copies of the originals. One of the paintings is anonymous—three are by Roland Savery, an eminent Dutch painter of animals, early in the 17th century, and one is by his nephew, John Savery. The first of these paintings is that copied in all books of natural history. It was painted in Holland, from the living bird brought from Mauritius. This picture, once the property of Sir H. Sloane, and afterwards of the artist Edwards, was by him deposited in the British Museum, where it is now in the bird gallery, along with the Dodo's foot. It is believed to have been painted by one of the Saverys, and to have represented a larger bird than that to which the foot belonged. At the Hague there is a painting by Roland Savery; the subject is Orpheus charming the animals by his music: innumerable beasts and birds are depicted with perfect accuracy, and among them, in one corner, the clumsy Dodo spell-bound, and although on a small scale, perfectly exact, even in the minutest particulars. The Dodo and all the other animals were evidently copied from living specimens.

At Berlin, Mr. Strickland found, in 1845, among several highly finished pictures by Roland Savery, one dated 1626, representing numerous animals in Paradise, one of which is a Dodo, which may have been painted from the living bird, brought home by the Dutch navigator, Van Neck.

There is also a picture of the Dodo, by Roland Savery, forming part of a larger picture, at Vienna; it is dated 1628. "There are two circumstances which give an especial interest to this painting, [see plate, p. 53.] First, the novelty of attitude in the Dodo, exhibiting an activity of character which corroborates the supposition that the artist had a living model before him, and contrasting strongly with the aspect of passive stolidity in the other pictures; and secondly, the Dodo is represented as watching an eel in the water." Are we hence to infer that the Dodo fed on eels, as the advocates of the raptorial affinities of the Dodo

would conclude? Our author, however, considers the eel as introduced for pictorial effect, believing and showing the Dodo to have been a frugivorous bird. In the British Museum, is still another picture of the Dodo, painted by John, nephew of Roland Savery, in 1651. It is a fac-simile of the pictures already mentioned; but it is exaggerated to nearly double of the size allotted to the Dodo; it stands 3 feet 6 inches high.

Conclusions respecting the Dodo.—"We must figure to ourselves,"—remarks our author,—"a massive, clumsy bird, ungraceful in form, and with a slow waddling motion," as a duck or gosling would appear if magnified to the size of a swan. Examples are not wanting in zoology, in which certain species or certain organs remain permanently imperfect, or only partially developed. The Greenland whale has only incipient teeth, that never penetrate the gums—as the mode of life of this animal and the nature of his food do not require mastication; the Proteus, living in subterranean caverns, retains the gills and the tail, which are dropped in the case of other Batrachians, and the eyes remain mere subcutaneous specks, without vision. So the Dodo remains a permanent nestling, as the Proteus is a permanent tadpole; it (the Dodo) is clothed with down instead of feathers, and the wings and tail are too short to admit of flight. The fishes and crustacea of the Mammoth cave of Kentucky, are eyeless, because in the dark cavern which they inhabit they have no occasion for eyes. Similar reasons might doubtless be suggested in other cases—but aside from such reasons, our author remarks, that the Creator appears to have assigned to each class of animals a definite type or structure, from which he has never departed; thus, if teeth are appropriate to a mammal, eyes to a vertebrate, and wings to a bird, we may understand why in a whale, the Proteus and the Dodo, these organs are only rudimentary—only suppressed, not annihilated.

We should be slow to impute imperfection to any of the works of the Creator; a definite structure is given to every animal, adapted to the conditions of its existence; "in this view every department of the creation is equally perfect—the humblest animalcule or the simplest Conferva being as completely organized with reference to its appropriate habitat, and its destined functions, as man himself. Such a view of creation is surely more philosophical than the crude and profane ideas entertained by Buffon and his disciples, one of whom calls the Dodo—'un oiseau bizarre dont toutes les parties portaient le caractère d'une conception manquée.' He fancies that this imperfection was the result of the youthful impatience of the newly formed volcanic islands which gave birth to the Dodo, and implies that a steady old continent would have produced a much better article."

To what class of birds does the Dodo belong?—Our limits will not permit a discussion of the various opinions which have been entertained by eminent naturalists. The Dodo has been reckoned a Gallinaceous bird—by others as a modified form of the Raptores, or birds of prey; some have endeavored to trace its analogies with the Penguins, others with the Ostrich, &c.

Mr. Strickland thus sums up the arguments that go to sustain the opinion first advanced by Prof. Reinhardt, of Copenhagen, and fully sustained by our author, which refers the Dodo to the Columbidæ, or pigeons.

"If now we regard the Dodo as an extreme modification not of the vultures, but of these vulture-like frugivorous pigeons, we shall, I think, class it in a group whose characters are far more consistent with what we know of its structure and habits. There is no a priori reason why a pigeon should not be so modified, in conformity with external circumstances, as to be incapable of flight, just as we see a grallatorial bird modified into an ostrich, and a diver into a penguin. Now we are told that Mauritius, an island forty miles in length, and about one hundred miles from the nearest land, was, when discovered, clothed with dense forests of palms, and various other trees. A bird adapted to feed on the fruits produced by these forests, would in that equable climate have no occasion to migrate to distant lands; it would revel in the perpetual luxuriance of tropical vegetation, and would have but little need of locomotion. Why, then, should it have the means of flying? Such a bird might wander from tree to tree, tearing with its powerful beak the fruits that strewed the ground, and digesting their stony kernels with its powerful gizzard, enjoying tranquillity and abundance, until the arrival of man destroyed the balance of animal life, and put a period to its existence. Such in my opinion," adds Mr. Strickland, "was the Dodo, a colossal, brevipennate frugivorous PIGEON."

This opinion is sustained by many anatomical and other considerations which we are obliged to omit. We have endeavored to present a condensed abstract of the historical and descriptive facts, and we have copied one of the figures, that a more definite idea may be obtained of the appearance of this remarkable bird.

The Solitaire, the brevipennate bird of the Island of Rodriguez.

The Solitaire, (Pezohaps solitarius, *Str.* and *Mel.*, Didus solitarius, *Gmelin*,) was also a bird of remarkable structure, and the evidence of its existence, although less abundant than that of the Dodo, is equally decisive.

Rodriguez, an island fifteen miles long by six broad, lying three hundred miles east of the Mauritius, is distinguished as being its birth-place.

In 1691, a party of French Protestants led by François Leguat, settled upon this island, then uninhabited, and remained there two years. Leguat was an intelligent and educated man, and has left a very interesting account of their adventures and of the productions of the island.

THE SOLITAIRE.

The most interesting part of his work, for our present purpose, is that relating to *the Solitaire*. Although, remarks Leguat, they are numerous, they are generally seen alone, or only in pairs and very rarely in flocks. On the males the feathers are brown gray; feet and beak like those of a turkey but more crooked; stern round with very little tail, but covered with feathers. Neck straight, longer than a turkey's, with elevated head. They are taller than turkeys. Eyes black and lively, and the head without a comb or cop. Being almost wingless they cannot fly; they beat themselves with their wings, making a noise like a rattle, and audible 200 paces off; they flutter when they call one another. They whirl twenty or thirty times together in the same direction during four or five minutes. Its defense is its beak and a little round

ball of bone at the end of the wing. They are difficult to catch in the woods, but are easily run down in open places.

From March to September they are fat and delicate, especially when young. Some of the males weigh forty-five pounds.

The females are very beautiful, and are careful to adjust their feathers with great exactness: those on their thighs are round like shells, and being very thick have an agreeable effect. They walk with so much stateliness and grace as to excite a degree of admiration which often saves their lives.

"Though these birds will sometimes very familiarly come up near to one when we do not run after them, yet they will never grow tame. As soon as they are caught they shed tears without crying, and refuse all manner of sustenance till they die."

M. Leguat contends with easy credulity, that the stone always found in their gizzards was there when they were hatched, because, as he says, the passage from the craw to the gizzard is too small to admit a stone of half the size. He says it is flat on one side and round on the other, and so hard that they found them excellent whetstones. Their nests are made of palm leaves and are eighteen inches high. They lay only one egg, which is larger than that of a goose, and the incubation is shared both by the male and female during their term of seven weeks, during all which period and for several months while their young are unable to provide for themselves, they repel every bird of their own species to a distance of 200 yards, the male bird repelling the males, and the female the females—the male calling her for this purpose when away, by making a noise with his wings. After raising the young bird, the parents are generally seen together and remain associated. M. Leguat relates, with some doubt whether he shall be believed, that a companion is brought to the young Solitaire, by a company of thirty or forty birds, some days after it leaves the nest, and the parent birds march with the band to some bye place, where they are left alone.

From the figure given by Leguat, the Solitaire must have been a bird of noble mien—stately like the wild turkey, but taller than that bird.

The dates of the plantane, a sort of palm tree, were among their articles of food.

Rodriguez is inhabited by a few colonists under the authority of England, but they state that no such bird is known to them; and Edward Higgin, Esq., of Liverpool, who was shipwrecked and remained two months on this island, avers the same, while he bears full testimony to the general accuracy of Leguat's book.

Although we cannot look for any living specimens of the Solitaire, we may expect that their skeletons will be found in the caverns and diluvium of Rodriguez. The legs and neck were longer, the beak shorter, and the wings, although useless for

flight, somewhat more developed than in the Dodo. It is now rendered certain from osteological characters, that the Solitaire was allied to the Dodo and not to the ostrich.

The bones hitherto found are not of a very decisive character, but they indicate analogies with the Dodo—and "as far as we can trace the points of agreement between these two extinct birds, they are shared in common with the pigeons and exist *in no other known families of birds.*" P. V. Strickland, in further confirmation of his views, refers "to the feeding on dates or plantains, the monogamous habits, the laying of only one egg, and the inability of the nestling to provide for itself." The first of these characters is not found in birds of prey—nor the three last in gallinaceous birds, but the whole of them are consistent with the habits of that anomalous family, the *Columbiadæ*. The sternal keel of the Solitaire, and the strong muscles of the breast imply that its wing although too short for flight, was an arm of defense.

On the whole, there appears to be good evidence, that Rodriguez was once inhabited by a splendid family of birds of the Columbine family, but of a larger size than any which now walk the earth. They were the cotemporaries of the Dodos, that other colossal and clumsy family of the Mauritius, and both might have remained to this day, had not the destroying arm of man been raised against them, so that they have been, for two hundred years, exterminated.

Brevipennate birds in the Isle of Bourbon.

"This volcanic island lies about one hundred miles south of Mauritius, and was inhabited by two species of birds whose inability to fly, and their consequent rapid extinction, bring them into the same category with the Dodo of Mauritius and the Solitaire of Rodriguez."

Captain Castleton visited Bourbon in 1613, and found "store of land fowl, both small and great, plentie of Doves, great Parrats and such like; and a great fowl of the bigness of a Turkie, very fat and so short winged that they cannot flie, beeing white, and in a manner tame; and so are all other fowles, as having not been troubled nor feared with shot. Our men did beat them down with sticks and stones."

In 1682, Bontekoe, a Dutch voyager, found in Bourbon, geese, parrots, pigeons and other game, also Dod-eersen, which have but small wings, and so far from being able to fly, they were so fat that they could scarcely walk, and when they tried to run, they dragged their underside on the ground. This navigator appears to have confounded this bird with the Dodo.

Carré, a Frenchman, in 1668, saw in Bourbon the so-called *Oisseau Solitaire*—a lover of solitude and frequenting the most

secluded places. It resembles a turkey, but has longer legs. "The beauty of its plumage is delightful to behold. It is a changeable color, which verges upon yellow. The flesh is exquisite; two of these shipped for the king of France, soon died of melancholy, having refused to eat or drink." Not long after Carré's visit, M. de la Haye, with colonists from Madagascar, visited Bourbon, and a gentleman of his party confirms the above account, but gives proof of a second species of brevipennate birds having inhabited these islands.

"*Solitaires.*—They are of the size of a large goose—white and black on the tips of the wings and tail; the tail feathers resemble those of an ostrich; the neck is long and the beak like that of a woodcock, but larger; the legs and feet are like those of turkeys. This bird has recourse to running, as it flies very little.

"*Oisseaux bleus*, the size of *Solitaires*—plumage wholly blue—beak and feet red, resembling the plumage of a hen. They do not fly, but they run extremely fast, so that a dog can hardly overtake them; they are very good eating."

The following conclusions are drawn by Mr. Strickland.

1. That a brevipennate bird, distinct from the Dodo of Mauritius, and from the so-called Solitaire of Rodriguez, formerly inhabited the Isle of Bourbon, probably without powers of flight.

2. A second brevipennate bird, the *Oisseau bleu*, was a native of Bourbon—although from its speed in running it probably escaped the notice of the earlier voyagers.

3. One species at least of the apterous birds survived in Bourbon, till about the middle of the last century. From the first colonization of the island, the woods were filled with birds that were not alarmed at the approach of man; among these the Solitaire (erroneously called the Dodo) was pursued on foot.

4. In 1763, there were still in Bourbon some curious birds which never descended to the sea-side, and which were so tame as to suffer themselves to be killed by the stroke of a walking stick; what they were is not known.

5. A brevipennate bird inhabited Madagascar less than two centuries ago. Flacourt, 1658, relates that the *Vouron patra*, a large bird, frequented the S.E. of Madagascar; it lays eggs like an ostrich—lives in desert places, and cannot be captured.

The three islands, Mauritius, Rodriguez and Bourbon—a group whose members are indeed somewhat remote from each other—were inhabited until the time of human colonization, by at least *four* distinct but probably allied species of brevipennate birds. An analogous case has been made out in New Zealand;*

* By Cotton, Williams, Colenso, Mantell, and others, with the aid of Owen's consummate anatomical skill. A vast collection of bones has been recently obtained with much toil and no small danger, by Mr. Walter Mantell, and sent to his eminent father, Dr. Gideon A. Mantell, who places them at Mr. Owen's disposal.

from abundant osseous remains, two new genera of brevipennate birds have been reconstructed. Seven species of Dinornis and two of Palapteryx have been ascertained, and two surviving species of Apteryx, present almost expiring members of the same zoological group.

PART II. of this work.—*Osteology of the Dodo and Solitaire.*

After making so full an abstract and analysis of Part I, by Mr. Strickland, containing the historical and descriptive facts, we regret to dismiss Part II, evidently the result of laborious and learned industry, without citations or any attempt at condensation or analysis; for the reason which will be obvious to any one who will look through the fifty-six pages quarto, chiefly in fine type, consisting of details in comparative anatomy, too technical to admit of the slightest variation in language, and already compressed within the most narrow limits consistent with perspicuity. To the great masters in comparative anatomy, we must consign the duty of giving an opinion in a case in which no verdict on the author's labors can be accepted unless from a jury of his peers, of whom the number duly qualified cannot be great.

No intelligent person, however, can fail to appreciate the proofs every where presented, of great acuteness in comparing and precision in describing, the wide range of affinities which are the subjects of discussion. We observe also, that several eminent continental naturalists coincide, either entirely or mainly, in the opinions entertained by the authors of the volume before us.

It is a striking example of refined investigation—an elegant specimen of the elaborate manner in which research is often carried forward at the present day—and the costume of the work is in full keeping with its contents. The lithographic illustrations are beautiful, and the diagrams of the bones must, we should suppose, satisfy the most fastidious anatomist.

In closing our remarks, we feel almost as if we had been copying epitaphs, and musing among the graves of gone by generations. We have had before us the painful story of the utter extinction of large families of birds, exceeding in size and equalling in interest any that are now living upon the earth. The great destroyer, man, has waged war from the days of Nimrod, upon the animal creation, and he spares only a few races, which are made subservient to his will. The time will come when the wide ranging buffalo of America will be found no more among living animals, and naturalists will gather up his dispersed bones, and labor to reconstruct his original form. A large proportion of the beasts that now roam our forests, may hereafter be known only in the history of the past.

SEN. ED.

ART. VI.—*On Single and Double Vision produced by viewing objects with both eyes: and on an Optical Illusion with regard to the distance of objects;* by JOHN LOCKE.

I HAD commenced the investigation of this subject so early as 1816, while I was a student of medicine in Yale College, and I have occasionally turned my attention to it up to the present time.

Although I have been fairly anticipated in the publication of some of my results, perhaps most of them, by the late investigations of Prof. Wheatstone,* and Sir David Brewster,† yet I deem it not useless to give you an account of the history of my own experiments and conclusions, especially as some of them are not, so far as I know, contained in the publications of either of the distinguished philosophers who have just written upon the subject. It is a well known phenomenon, that with both eyes open we can see a single object either single or double, according as the axes of the eyes are made to converge and meet either at the object, or at a point nearer than that object. Having acquired the power of voluntary convergence of the optical axes to an extreme degree without the aid of viewing near objects, such as the nose, or a finger held near to the eyes, I commenced my experiments as follows:

Experiment I.—I viewed a burning candle at the distance of about eight feet, the axes of the eyes being "crossed" or extremely converged. Two images were of course seen, the distance between which could be varied at pleasure by the amount of that convergence. The two images of the candle being thus seen, I suddenly closed one of my eyes, when the image on the *same side* of the closed eye vanished. Thus on closing the right eye, the right image disappeared, and on closing the left eye, the left image became extinct.

Inferences.—1st. As the axis of the right eye was directed to the left of the object and the image which disappeared on closing that eye was to the right of it, that image must have been an *oblique* one, seen as we see lateral objects to which the eyes are not directed. It appears too, that while the axes were converged upon vacancy, the oblique image in the right eye took the place of an image formed directly in the axis of the left eye, and the same relatively of the left eye; thus each eye *appeared to have* an image in its axis, which image was really in the opposite eye.‡

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* I have not seen his paper. † Phil. Mag., May, 1847.

‡ This is not always the condition of strabismus, for one eye may be so directed that the axis shall be on the object while the other is oblique.

2d. The two oblique images on the retina must have been formed on points nearer to the nose, or nearer to the medial line of the body than the principal axis of perfect vision.

3d. The images appeared in such position as objects should have been to produce pictures on the same parts of the retina, *the axes being at the same time parallel*, or nearly so.

4th. As with both eyes we see a lateral object ordinarily single, especially when at the same distance as the principal object viewed, it is inferred that the two pictures, one in each eye, must fall on parts of the retina not correspondent to the medial line of the body, in order to produce single vision. For example, on looking at a person standing ten yards in front, the image of a person standing two yards or more to the right will appear *single* though not well defined. The picture of this second person must in such case be formed to the left side of the retina of both eyes, *towards* the nose in the right eye, and *from* it in the left eye. In these two situations on the retina and in no other, will the two oblique pictures present a single image to the mind.

5th. All this establishes the principle that *certain parts of the retina of one eye* CORRESPOND *to certain specific parts of the retina of the other eye, in such a manner that when identical pictures fall on those corresponding parts, single vision is the result.* Those corresponding parts lie inward in one eye, and outward in the other, viz.: both to the right or both to the left. From each of those corresponding parts of the retina, it is probable that the fibres of the optic nerve proceed, and severally unite at the point of anatomical communication where the optic nerves cross, before entering the brain; hence the single impression or single image.

It may be added to this experiment (I), that if the finger be pushed against the under part of the eyeball so as to roll it upward, the image in that eye will appear to descend, and double vision will thus be the result. Here the eye being rolled upward, the image falls on the upper part of the retina; hence the impression of a lower object would form a picture on that part, *were the eye not distorted.**

Experiment II.—Two candles of equal size and height were placed side by side on the table, and, by converging the axes of the eyes, four images were produced. As the convergence progressed, each pair of images receded gradually from the original place of the single image until the two contiguous ones, the second and third, approached, and finally coalesced into one, when three images only were in view. The same experiment may be made with two letters or any other figures or objects which are equal in size and form, as follows:

* In all cases the mind seems to make no allowance for distortion of the eye, but refers the image to its true place were the eye in its natural position.

1. A A Natural single vision.
2. A A A A View with axes slightly converged.
3. A A A { View with greater convergence of the optical axes and the two intermediate images coalesced into one.

On suddenly closing either eye, this middle or superimposed image did not disappear, and it was evidently made of two images from *two objects* formed on corresponding parts of the retinæ. Hence we have the converse of the case of double vision of a single object: for two objects are made to produce a single impression. Thus far I had proceeded in 1816, when I read a paper on this subject to a club of my fellow students at Yale.

Experiment III.—In 1843, I made the experiment of converging the optical axes upon two contiguous figures on the wall paper of my office, in the same manner as I had done with the two images of the two candles in Exp. II. When I had thus succeeded in taking up optically the two figures and superimposing them one upon the other, suddenly the whole wall appeared to leap out from a distance of ten feet to within half a yard of my eyes, where it remained in miniature beauty as palpable to vision as it had been in its original place. To this image, suspended as it were between the observer and the object, I shall, in the subsequent part of my paper, apply the term illusive image.

It then appeared that the right eye was directed to the left one of two contiguous figures, and the left eye to the right figure, which being identical in form and size, gave the impression of a single object at the point of intersection of the optical axes. Here we have two triangles formed by the two optical axes intersecting each other and joined at their extremes, on one part by a line from one eye to the other, and on the other part by a line from one figure or object to the other. These last lines being parallel,

(see figure,) where A and B represent the eyes, C and D, the objects, or two figures on the wall; AD the axis of the eye A, BC the axis of the eye B, and E the point of intersection of the axes at the place of the illusive image. As these triangles are equiangular and similar, we can deduce from them all of the equations of such triangles and apply them to the optical phenomena. Thus the distance from the eye to the illusive image (AE) will be to the distance from the object to the same image (DE) as the distance between the eyes (AB) is to the distance between the objects (CD) the figures or pannels on the paper, &c. &c.

It is not merely the two objects directly in the axes of the eyes which coincide, but every contiguous pair of objects seen ob-

liquely will also coincide, and form the illusive picture in extenso. Indeed the optical operation of convergence seems like taking up a duplicate copy of the figures lying in the first place exactly over them, and slipping it gradually to the extent of one figure, until again the figures coincide in a new place.

Some of the phenomena of the Illusive Image.—It is quite perfect, and can be viewed deliberately and critically as if it were a real substance in place as it appears; the figures are smaller than the originals in proportion as they are nearer; as the outlines are a little blended by double pictures not exactly coincident, an elegant softening and a playful beauty exalts their effect above that of the original; as the head moves sideways, upward or downward, the illusive image moves, but with a diminished motion; as the head is inclined to the right or left, the superimposed pictures slide out from each other, the one ascending and the other descending to the extent of the inclination.

Optical Equivalency.—The illusive image and the erroneous distance at which it appears, show evidently that philosophically we do not *see an object*, but we contemplate an image on the retina. If this image can by any means be formed without the object, we still contemplate the substance such as would produce that image. Thus in Experiment III, and the figure illustrating that experiment, the two objects C and D produce each picture in the eyes at A and B, exactly as would be produced by a single object of smaller size at E. Thus the two objects, one at C and the other at D, "fulfill the conditions of the problem" of the images on the retina, exactly as it would be fulfilled by a single smaller object at E. In both cases, identical pictures are formed on "corresponding" parts of the two retinæ. Hence the two objects produce the impression of a single image.

Directions how to make the experiment of the Illusive Image.—With two identical objects only, although it is easy to superimpose them as in Experiment II, yet the illusion of distance can scarcely be attained. But with a papered wall having a repetition of the same figure at equal distances, a person who has voluntary command of the optical axes will soon move the double images to coincide, when presently the illusion will be perfect. Persons who have not this command of their eyes may succeed in obtaining the proper convergence by looking at a finger held about fifteen inches from the face, while standing ten feet from a wall with figures twenty inches apart.

Apparent distances of objects.—It seems that we judge of moderate distances by a kind of triangulation, the distance between the eyes being a constant base line. In order to put this to the test, I have several times made the actual measurements as in the following cases:

Having measured the distance between my eyes, 2·6 inches, the distance between the figures on the wall 21 inches, the distance from the wall ten feet, the distance of the illusive image was calculated to be 14·7 inches, when it had been measured as near as may be 14·5 inches. In a second experiment we endeavored to ascertain the distance of the observer from the wall. The other data were:

Distance between the eyes,	2·6	inches.
Distance between the figures,	21	inches.
Distance of illusive image,	16·75	inches.
Calculated distance of the wall,	12·5	feet.
Measured distance of wall,	13·15	feet.

When it is recollected that the observer is obliged to range lengthwise on his measure while he determines the distance of the aërial image, and that the base line is only 2·6 inches, the above results appear quite as accurate as we ought to anticipate.

There is peculiar beauty and accuracy in some of the results of these experiments, and it had occurred both to Sir David Brewster and myself, that when a strip of wall paper was placed at a greater or less distance from its fellow than others, the illusive image would not appear in the same place, some strips would advance a little and others would recede, so as to fulfill the conditions of the triangles above named; even the sixteenth of an inch would be appreciable.

In the history of my examination of this subject, I would observe that my friend Dr. D. S. C. H. Smith, of Sutton, was present when my paper was read at New Haven. In 1845, my assistant, Thos. K. Beecher, A.M., witnessed and repeated most of the experiments above named. Among other things we made the equations dependent upon the above triangles, and verified our calculations by actual admeasurement of the distances between the eyes, between the objects, and to the illusive image. I attempted a popular lecture on this topic, but found it difficult to interest an audience in a matter requiring so much previous optical knowledge. In the spring of 1846, I communicated the leading principles of what I thought then questionable discoveries, either to Prof. Bache or to Prof. Henry, and consulted him as to their originality. He gave his opinion that they were new. Without the least disposition to contest the point of originality, which I have failed to establish by neglecting to publish my results, I wish merely to inform my friends of what I have in fact done, and thus appear as a collateral witness to the truth and interest of Sir David Brewster's paper. He has brought forward some points which had never presented themselves to me. That figures less distant than the two eyes may be so viewed as to form an illusive image at a greater distance than the object itself, is evidently true, yet I had never made or anticipa-

ted the experiment. Two such small figures might occupy such a situation as to form the pictures on the retina due to a single larger object placed at a greater distance, and thus become an optical equivalent to that object. I am now experimenting on the subject of single vision produced by two identical figures of different colors. So far the results have not excited any very surprising interest. The illusive image, as would be anticipated, usually exhibits the effect of a commingling of the colors, but by directing the attention to one or the other eye, one or the other color may be made to predominate. Thus a cameleon picture is formed, changing color at the will of the inspector.

Sir David Brewster alludes in his paper to some discoveries made by Prof. Wheatstone, in reference to "binocular" vision of objects of three dimensions. I have not seen the paper on that subject, nor had I turned my attention in the least to its consideration, yet so intimately is it connected with the principles just laid down, that upon its being named certain important conclusions at once present themselves. Thus when the hand is held edgewise, within three inches of the nose, one eye will receive an image of the palm and the other of the opposite side, and the two pictures being dissimilar, cannot fall on corresponding parts of the retina and produce a single perfect image. Let any one make the experiment, and he will perceive that Hogarth's caricature of bad perspective, in the figure of a barrel with both ends visible at the same time, was not altogether absurd, for if the barrel be shorter than the distance between the eyes, it is practicable. The same thing will occur with regard to any solid, as a cube, which has several aspects, and the imperfection will be evidently greater as the object is smaller and nearer the eye.

The experiments on this interesting subject can be extended and varied in many ways highly interesting and instructive; and as no other apparatus is required than our eyes and the objects of our inspection, it would seem that they were easily made. But it requires rather an acquired power over the organs of vision to be readily successful. Sir David Brewster applied "binocular" convergence upon two figures, drawn side by side to superimpose one upon the other, and compare their exactness in point of size and form. I have extended the same operation to figures of unequal size, though of the same form. My son had just completed a half size copy of a drawing representing an Arab on horseback, the correctness of which had been questioned. It was evident that being placed at distances proportionate to their size, the images of the original and copy on the retina would be equal when a consistent illusive image might be obtained by convergence. The original was hung on the wall, and the half size copy suspended at about half the distance from the observer, at such an angle that one could be fully seen beside the other. I

converged or superimposed the images, and found them so nearly to coincide, that the common outline was merely elegantly softened by the inequalities. In this experiment it appeared as if the eye, when the figures did not exactly coincide, had some power to complete the work or conceal the imperfections.

I have just succeeded in substituting a blank tablet for one of the pictures, and in tracing upon it with a pencil the illusive image converged from the other tablet. But this is not a very practicable method of copying pictures, requiring unusual command and steadiness of the optical axes for even the most moderate success in the operation.

ART. VII.—*Analysis of the Bittern of a Saline on the Kiskiminetas River, near Freeport, Armstrong County, Pennsylvania;* by M. H. BOYÉ, M.D., A.M.

(Read before the American Assoc. for the Advancement of Science, Philad., 1848.)

THE mother liquid, which remains after the brine has been so far concentrated as to yield no more salt by crystallization, is generally termed bittern, and thrown away. A great difference exists in regard to the quantity of bittern which remains at the different salines, some of them yielding a large amount of it, others leaving hardly any. The bittern which is the object of the present examination, was taken in the fall of 1841, from the first saltwork on the Kiskiminetas river, above Freeport, situated on the canal. It was selected on purpose from this saline, which was said to yield it in larger quantity than any other in the neighborhood, with a view to examine its chemical constituents, and more particularly to test it for *bromine*. Owing, however, to several causes, the examination was not begun till the spring of 1844. In the quantitative estimation of the different ingredients, I have been assisted by Mr. J. Hewston, a pupil of the High School.

The water had during its long standing, deposited at the bottom of the bottle in which it was contained, a crust of common salt, covered with a slight film of oxyd of iron, from which it was separated by careful decantation and subsequent filtration. By a qualitative examination, the water was found to contain lime, magnesia, soda, and a trace of potassa, in combination with chlorohydric acid. By the passage of chlorine through it, and subsequent shaking with ether, the latter assumed a rich orange color, indicating at once the presence of bromine. Chlorid of palladium indicated only a trace of iodine. It contained no sulphuric acid and no lithia.

Quantitative estimation.—1. The specific gravity of the liquid was ascertained, by weighing in a glass bottle, to be 1·339. Its

content of lime and magnesia in combination with chlorohydric acid, rendered it impossible to determine with accuracy by direct evaporation, its content of solid matter. It will however be seen from the following, that the solid ingredients contained in it amounted to 35·79 per cent.

2. A weighed quantity of the bitter water was super-saturated with ammonia, which produced no precipitate, and mixed with oxalate of ammonia until all the lime was effectually precipitated as oxalate of lime. The latter was collected on a filter, washed and incinerated with the usual precautions, and from the weight of the carbonate the amount of pure lime calculated. The filtered solution was evaporated to dryness, the ammoniacal salts expelled by heat, the residuary mass mixed with a small portion of water and oxyd of mercury and again evaporated to dryness, and ignited. On treating the mass with water, the magnesia remained undissolved. It was collected on a filter, washed, incinerated and weighed. The filtered solution was evaporated to dryness, and the weight of the remaining chlorid of sodium ascertained. By subsequent solution in water, and addition of chlorid of platinum and alcohol, it only yielded a minute portion of chloro-platinate of potassium.

3. Another weighed portion of the bittern was diluted with water and mixed with a sufficient quantity of dilute sulphuric acid; then an equal volume of alcohol of the ordinary strength was added to the whole mass. The precipitated sulphate of lime was collected on a filter, washed with a mixture of 5 vol. of alcohol and 6 vol. water, incinerated and weighed, and from it the amount of lime calculated. The filtered liquid was evaporated to dryness and ignited, and yielded the joint weight of the sulphates of magnesia and soda. These were then dissolved in water and precipitated with acetate of baryta. The filtered solution was evaporated to dryness, charred, and by treatment with water the carbonate of soda dissolved from the insoluble carbonates of magnesia and baryta. The former was separated from the latter by extraction with dilute sulphuric acid, and the amount of sulphate of magnesia estimated. Deducting the latter from the joint weight of the sulphate of magnesia and soda, the amount of sulphate of soda was obtained, from which that of the soda was calculated. As stated above, it only contained a small amount of potassa.*

4. Another smaller portion of water was acidulated with a few drops of nitric acid and then precipitated by nitrate of silver, and the weight of the chlorid of silver with its smaller contents of bromid and iodid of silver ascertained.

* This method of separating lime when in preponderating quantity by sulphuric acid and alcohol, the convenience and accuracy of which I pointed out in an essay on the analysis of magnesian limestones, by R. E. Rogers and M. H. Boyé, Journ. Franklin Inst., March, 1840, I cannot sufficiently recommend.

5. The accurate quantitative determination of bromine in connection with larger quantities of chlorine, is as is known connected with difficulties, and different experiments performed after the different methods recommended, yielded different results varying from 0·3 to 1 per cent. The result adopted in the following, was obtained by distilling a certain quantity of the water with peroxyd of manganese and a small but sufficient quantity of chlorohydric acid, receiving the bromine in a small globular receiver containing ammonia, and in the tubulure of which was fixed a modification of Liebig's potassa bulb, as employed by Will and Varrentrap in the analysis of nitrogenized organic compounds, but in this case containing, like the receiver, ammonia. The chlorid and bromid of ammonium thus obtained were decomposed by evaporation to dryness with caustic baryta, the mass treated with water, the excess of baryta precipitated by carbonic acid, and then the bromid and chlorid of barium precipitated by nitrate of silver, and the weight of the bromid and chlorid of silver ascertained after perfect desiccation on a counterpoised filter. It was then treated with nitro-muriatic acid by heat and its weight again ascertained, and from the difference in weight the amount of bromine calculated.

6. The amount of iodine was determined by precipitation of chlorid of palladium, and ascertaining the weight of the iodid of palladium.

Taking the mean of §§ 2 and 3, the results of the analysis were as follows:

	In 100 parts of the water.
Potassa,	0·081
Soda,	0·464
Lime,	12·560
Magnesia,	4·200
Chlorine,	23·068
Bromine,	0·701
Iodine,	0·0035

from which the following composition of the water may be derived.

	In 100 parts of the water.	
Chlorid of potassium,	0·128	
Chlorid of sodium,	0·877	
Chlorid of calcium,	24·640	
Chlorid with Bromid and Iodid of magnesium,	10·146	Mg. 2·575 Cl. 6·866 Br. 0·701 I. 0·0035
Water,	64·209	
	100·000	

Philadelphia, Nov., 1844.

ART. VIII.—*On the Comparative Value of different Kinds of Coal for the purpose of Illumination; and on Methods not hitherto practised for ascertaining the Value of the Gases they afford;* by ANDREW FYFE, M.D., F.R.S.E., F.R.S.S.A., Professor of Chemistry King's College University, Aberdeen, &c. Read before the Royal Scottish Society of Arts, April 24, 1848.*

IN a paper published in the Transactions of the Society for 1842, I gave an account of numerous trials made with the view of ascertaining the value of different kinds of coal for the purposes of illumination. Having been again engaged in conducting experiments for the same purpose, I have been induced to make some of the results public, because I conceive that they are interesting, and lead to valuable practical applications.

The objects which I have had in view were to ascertain not only the *comparative amount of light* afforded by the gases which the coals yield, but also the *durability* of these gases, so as to enable me to fix, as far as possible, their *comparative value*, and, consequently, their comparative *expense*, for the purpose of illumination. Besides these, however, my attention was drawn to other circumstances connected with the consumption of gas, which, strictly bearing on the other part of the inquiry, are of importance.

1. *Quality of the Gases.*

In estimating the quality of coal-gases, and, consequently, fixing their comparative value for the purpose of illumination, we must take into account both the light afforded, and the time required for the consumption of equal volumes.

In trying the former, I have, in the following experiments, invariably had recourse to the method mentioned in my former papers, viz., the condensation by chlorine, and in which, now that the trials have been greatly extended, I place the utmost confidence.

For ascertaining the latter, I have followed the usual method,—an accurately-adjusted experimental metre; by which the times required for the consumption of equal volumes, burning under similar circumstances, and also the quantity consumed in equal times, were easily determined. The jet burner was the same in all the trials.

I consider both of these circumstances absolutely necessary, for, though some have insisted only on the one, and others on the other only, yet, unless both be taken into account, we do not

* From Jameson's Jour., Edinburg, vol. xlv, pp. 37—49.

arrive at the true *value* of the gases, and, consequently, cannot compare one with another for the purpose of illumination. Thus, if two gases afford, by their combustion, from the same or similar burners, with the same height of flame, the same light; but if a foot of the one lasts an hour, and a foot of the other an hour and a-half, then the latter is one-half more in value than the former for yielding light, because it is giving the same light for one-half more time; or, which is the same thing, one-half more of the former must be used so as to complete the time which the latter will burn. This, I regret to say, has been too often overlooked by many in estimating the value of coal-gas.

As the chief object I had in view was, not the comparison of the light afforded by coal-gas, or its expense, as compared with other sources of light; but merely the value of the gases as *compared with one another*, when obtained from different coals, I shall commence with that from English caking coal, and take it as the unit for comparison.

English Caking-Coal Gas.—The gas from this kind of coal, on which my experiments were made, was that from Newcastle; others were also procured by means of an experimental apparatus, fitted up expressly for the purpose. The condensation by chlorine in the former, was, on an average of several trials, 4·33 per cent.

The specific gravity, at Th. 60, B. 30, was 420.

The durability, with a four-inch flame, from a platinum jet, $\frac{1}{35}$ of an inch in diameter, was 1 cubic foot in 50 minutes 30 seconds. The pressure by water-gauge at the burner was $\frac{1}{10}$ of an inch.

From 1 ton of coal, about 8000 cubic feet of gas are obtained.

The gases obtained with my experimental apparatus, from a variety of samples of the same kind of coal, both lately and several years ago, were very nearly of the same composition. Different heats were used in driving off the gas, with the view of finding the best heat. The condensation by chlorine varied from 3·5 to 5·5; the average of the trials, amounting to eight, was nearly 5. The durability varied from 47′ 20″ to 53′ 30″; the average being 50′ 25″.

The average specific gravity of eight different gases was 464, the highest being 512, the lowest 414.

As above mentioned, I take the gas from this kind of coal for illuminating power and durability, and, consequently, for *value*, as my standard of comparison.

English Cannel-Coal Gas.—The gas obtained from this kind of coal, such as that from Wigan in Lancashire, with which Liverpool, Salford, and other places are supplied, and that from coals found in different parts of Yorkshire, which are occasionally used at Manchester, are very nearly of the same quality.

The *Yorkshire Parrot Coal*, in its appearance and quality, is altogether different from the English caking coal. It more nearly resembles the parrot coal of Scotland. The condensation by chlorine was 7·66; the durability, 52′ 30″; pressure at burner, $\frac{6}{10}$. A ton of coal yields about 11,500 feet.

I have already stated, that the chlorine test, with English caking-coal gas indicated 4·33, that with the Yorkshire cannel-coal gas being 7·66; consequently, the illuminating power is as 1 to 1·76. The durabilities being 50′ 30″, and 52′ 30″, they are as 1 to 1·03; both taken together, makes the value of the latter, for the purpose of illumination, 1·81, to the former, as 1·(1 : 1·76 :: 1·03 : 1·81).

Wigan Cannel-Coal Gas.—I have had several opportunities of testing the quality of gas from this kind of coal, as at Liverpool, Salford, &c., at which the gas was found to be of the same quality. The chlorine indicated 7·55. The durability was 57′; the pressure at the burner, $\frac{5}{10}$ths and $\frac{9}{10}$ths; sp. gr. from 460 to 520. The quantity of gas from a ton of coal was 9,500 feet.*

Newcastle coal-gas being by the chlorine 4·33, and the Wigan cannel gas, 7·55, they are as 1 to 1·73. The durability being 50′ 30″ and 57′, they are 1 to 1·12. Taking both into account, then the value is as 1 to 1·93 (1 : 1·73 :: 1·12 : 1·93), which is nearly the same as that of the gas from Yorkshire cannel, already given as 1·81. We may take the average value of the gas from English parrot coal, so far as these trials go, as 1·85, compared to that from English caking coal, as 1.

Scottish Parrot Coal.—I have had many opportunities of testing the quality of gas from this kind of coal, not only as manufactured at gas-works, but also when made by my experimental apparatus in Edinburgh and Aberdeen. I have already in a paper, published in the Transactions of the Society, for 1842, given the results of numerous trials conducted in Edinburgh. I have now to allude, not only to those made in different towns of Scotland, but also to a very extended series, more lately carried on with the experimental apparatus.

The gas, from all the varieties of Scottish parrot coal, is of superior quality to that from the best English parrot; but it varies very much according to the kind of coal. In all of the towns in Scotland that I have visited, a mixture of one of fine quality, and of one or more of inferior quality, is employed in the manufacture of gas; partly, because the former cannot be got in sufficient quantity; partly, because it is too expensive; and hence, with one or two exceptions, chiefly in the smaller towns, the quality of the gas was found to be very nearly the same.

* In one instance I found the quantity of gas amount to 11,500 feet; but in this case the quality of the gas was not so good. I prefer, therefore, taking the one above.

In the paper already alluded to, I have stated the condensation by chlorine, with the gases prepared from the coals there mentioned, to vary from 9 to about 20. With two exceptions, I never found it under 12; the average of all the trials, amounting to upwards of 20, may be taken as 15, that is, very nearly double of that with the English cannel coal; and 3·46 as great as that with the English caking coal; thus making the illuminating power, English caking 1, English cannel 1·85, Scottish cannel 3·46. The English cannel being 1, the Scottish cannel is 2, or very nearly so.

The trials with the same gases shew the durability to vary from 56′ to 94′, with the two exceptions above mentioned, it was not below 70′—the average of the trials was 80′; making the durability as 1·58 to the Newcastle, and 1·48, or 1·45 to the average of the English cannel as 1. Now, taking both into account, the value of the Scottish parrot-coal gas, bulk for bulk, for affording light in these trials, is as 5·46 to Newcastle as 1, and 2·68 to English parrot as 1.

Since these experiments were made public, I have been engaged in a very extensive series of trials with parrot coals procured from Fifeshire, the Lothians, and the Western districts of Scotland, so as to ascertain the value of the gases which they afford. The gases were manufactured with the experimental apparatus, and under a variety of circumstances, so as not only to secure accuracy, but also to observe how far the manufacture, &c. is affected by a difference in the mode of conducting it. It is not my intention to allude to these farther than to state, that, taking the average of the trials, amounting to upwards of 40, I found the chlorine test, and the durability to be very nearly the same as those given above.

With regard to the gas with which the towns in Scotland are supplied, I have already said, that in manufacturing it, a mixture of different kinds of coal is employed, according to the situation of the town, and the supply that can be obtained. At Edinburgh, the coal is chiefly from the Lothians and from Fifeshire. At Glasgow, it is got from Lesmahago, Kelvinside, Wilsontown, &c. At Greenock, Monkland and Skaterig coals are employed. In the towns in the north of Scotland they are obtained chiefly from Lesmahagow and Fifeshire.

The price of coals varies according to the kind of coal. At Edinburgh and in the west, it is from about 20s. to 23s. per ton. In the north, however, it becomes higher and higher, according to the distance, and, consequently, to the carriage from the pits.

In the larger towns that I have visited, I have found very little variation in the quality of the gas obtained from the different mixtures used. The chlorine indicated from 13 to 15; the average may be taken as 14. The durability was from 70′ to 90′,

very rarely below 80,—on an average, it was a little beyond 80, say 80. The pressure at the burner varied from $\frac{6}{10}$ths to $\frac{7}{10}$ths. The sp. gr. was, on an average, about 640. Thus, then, the illuminating power of the gas with which the towns in Scotland are supplied, is, on an average, as 3·23 to the Newcastle coal gas, and 1·85 to the average of English cannel, both taken as 1. The durability is as 1·58 to English caking, and 1·45 to the other, both as 1. Accordingly, taking both into account, the value of these gases, bulk for bulk, for the purpose of illumination, is English caking 1, English cannel 1·85, the average of the gas in the towns of Scotland 5·1, say 5. Taking the English cannel-coal gas 1, then the Scottish is from 2·63 to 2·72, say 2·7. From the mixed coal employed in different towns, a ton yielded on an average 9500 feet of gas.

2. *Value of Coals for the purpose of Illumination.*

Keeping in view what has now been said regarding the quality of gas which the different kinds of coal afford, an estimate may be formed of the comparative value of these coals for that purpose, independent of the price paid for the coals, and also of the returns made for coke, and other matters disposed of, such as ammonia, &c.; and in doing so, I still take the *English caking coal as unity.*

A ton of English caking coal yields, on an average, at gas-works, 8000 feet of gas, and though a larger quantity was given with my apparatus, yet we must take 8000 as the quantity on a large scale. The value of the coal is taken as 1.

The *Wigan cannel* yielded 9500 and 11,500; the value of the gas, bulk for bulk, being the same, viz., 1·85 to the former as 1. Now, taking into account the quantity of gas afforded, the value of the coals for yielding light, by the consumption of their gases, is as 2·23 for the one quantity, and 2·5 for the other; taking the average, we state the value of English cannel coal as 2 35, or say 2⅓ to Newcastle caking coal as 1.

Scottish Parrot.—While the English cannel coal may be considered as of the same value at different places, it is not so with the Scottish parrot. I have said that it varies very much in different districts; and hence, though the value of the gases with which the different towns are supplied is very nearly the same in all, owing to mixtures of coals of superior and inferior quality being used, yet the value of the different coals varies considerably, owing to the quality and quantity of gas which they afford varying.

I have taken the average value of the Scottish parrot-coal gas as 5, compared to that from the English caking coal as 1. The quantity of gas from the latter being 8000, and that from the

former 9500, then the value of the coals for the amount of light afforded by the combustion of their gases, is as 6·1 to 1.

The above must be considered as the value of the Scottish parrot coals *on an average*, or as used in their *mixed state*, as is generally done by gas companies. It may be interesting to state the value of some of the coals themselves. The poorest Scottish parrot I have yet examined yielded only 9000 feet of gas, the value of which was 2·2 to that of English caking-coal gas as 1; making, accordingly, the value of the coal for yielding light only 2·5, or very nearly so.

The value of the gas from Lesmahago coal, which by gas-makers is generally considered the best in the market, I have found to be 6·6 to the English caking-coal gas as 1; the quantity of gas being 1·13 to 1; accordingly the value of Lesmahago coal is at least 7 to 1. Since the publication of my paper in 1842, I have had more valuable coals submitted to trial; but as these are not, so far as I know, in the market at present, they must not be taken into account in fixing the average value of Scottish parrot coal. As above stated, we must still consider the value of this coal as about 6, to the Newcastle caking as 1; of course its value compared with the English cannel, will be 2·6 to 1.

I have said that the value of the coke has not been taken into account in these calculations; it must, however, be borne in mind, that, while I have fixed the value of the Newcastle coal for affording light by the combustion of its gas, as very low, compared to that of the cannel coals, yet, taking into account the greater quantity of coke which it yields, and the higher price at which that coke is sold, the value of the coal to gas-manufacturers becomes comparatively greater than I have stated, of course, in this point of view, reducing the value of the others as compared with it; but then this has nothing to do with the question under consideration, viz., the comparative value of the coals for affording light by the combustion of their gases.

3. *Expense for Light by different Gases.*

Having fixed the value of the gases obtained from the varieties of coal mentioned, I have now to advert to the prices paid for the gases at different places, with the view of shewing the comparative expense to consumers for the same amount of light.

In examining this part of the subject, a difficulty occurs, owing to the different methods followed in charging for gas in different towns. The following remarks must therefore be considered only as an approximation to the truth.

English Caking-Coal Gas.—The charge for this gas is about 4s. 6d. per 1000 feet, as at Newcastle, subject to discount, by which, and by charge for street-lamps, the average price may be taken as 3s. 10d. Let us take this as unity.

In the different towns I have visited in England, where *English cannel coal* is used, the charge varies from 4s. 6d. to 5s. 6d. Suppose we take the average at 5s., then the comparative charge for it, and for English caking-coal gas, is as 1·3 to 1. But the value of the gases, bulk for bulk, for the purposes of illumination, being as 1·85 to 1, then the comparative price paid for the same amount of light is only 75 to 100.

The price charged for the *Scottish parrot*-coal gas varies considerably in different towns, owing chiefly to the difference in the expense of coal. I have found it to vary, in the larger towns, from 5s. to 7s., but, making allowance for discount, it goes from 5s. to 6s. 6d. Taking it as 5s., then the charge, compared with the English caking-coal gas, is 1 to 1·3; taking the *value* of the gases into account, the price paid, for equal amounts of light, is as 25 to 100; accordingly, to light to the same extent with these gases, the expense for the English gas is four times as great as that for the other. At 6s. it would be 30 to 100, and at 6s. 6d. it would be 33 to 100; and hence the price paid for equal amounts of light varies from one-third to one-fourth of that paid for the English caking-coal gas.

I have given the comparative value of the English parrot-coal gas, and of the Scottish, as 1 and 2·7, the average price for the former being 5s., that for the latter 5s. 6d., and 6s. 6d. For the first, the price paid being the same, the expense for equal lights will be inversely as the value of the gases, 2·7 to 1; at 6s. 6d., the highest charge, the comparative expense is about 2 to 1. Accordingly, the expense paid for the same extent of lighting by these gases, varies from about 2 to $2\frac{3}{4}$ for the English, to the Scottish as 1; that is, the expense for a given amount of light, for a certain time, by Scottish gas being 1, that for the same light, during the same time, with the English parrot-coal gas, is from 2 to $2\frac{3}{4}$, and for the English caking-coal gas, from 3 to 4, according to the price paid for the Scottish gas.

In making these remarks regarding the value of the gases in different places, and the consequent prices paid for equal amounts of light, I trust it will not be supposed, that I mean to insinuate that the price paid by consumers of gas in England for their light is too great, and that consequently, it ought to be reduced, so as to bring it to a par, or nearly so, with that paid in Scotland. So far from that being the case, I believe, that, at present, some English gas companies are charging for their gas a price which does not remunerate them; and that, instead of it being lowered, it ought to be raised. It must be borne in mind, that the price of gas, like that of other manufactured goods, must be regulated, in a great measure, by that paid for the raw material; and it so happens that, in England, they are not so fortunate as we are in Scotland, where there is a coal, which, though much more

expensive than the English coal, yet is superior to it for the manufacture of gas; in so far that it yields an article of much higher value for the purposes of illumination; but, then, were this coal used in England, it would, most probably, owing to carriage, &c., become so expensive, as to cause the charge for the same light to be greater than at present.

In considering the results of the trials now recorded, the most superficial observer must be struck with the remarkable fact, that gases, having the same illuminating power, require, with the same burners, very different times for the consumption of equal volumes; and hence, as I have already said, it is necessary, in ascertaining the *value* of a gas, for the purpose of illumination, to take into account, not only the illuminating powers, but also the durability. Though I alluded to this in a former paper, published in the Transactions of the Society for 1842, my attention has been more particularly drawn to it during the investigations in which I have been lately engaged, by observing the striking difference between the durabilities of gases obtained from Scottish cannel coals, procured from different districts; and hence, the remarkable circumstance, that two coals may both yield the same quantity of gas, and which gases, when burned under similar circumstances, are of the same illuminating power, yet these coals may be of different value for the manufacture of gas, in so far, that the gas from the one will burn a longer time than that from the other will do, when consumed in the same way. This is well illustrated with the coals of the Lothians, and of the west of Scotland. Thus, the average condensation by chlorine, of the gas from the Marquis of Lothian coal, was, in my trials, 13·125, the average durability 59′ 30″; while, with the Lesmahago coal gas, the former was 15·77, but the latter was only 62′ 24″. Had the one been in proportion to the other, the durability ought to have been 71′ 30″, or nearly so. The same remark is applicable to the varieties of coal from the west of Scotland, when compared with one another. Thus, the average indication by chlorine, with Skaterig and Knightswood coal gas, was 9, the durability 46′ 45″. With the Lesmahago, as above, they were respectively 15·77 and 62′ 24″. The latter, to keep pace with that of the former, ought to have been 81′ 54″.

I have observed similar results in trials which I have lately made. Thus three coals, submitted to experiment, yielded gases, the indication of which, by chlorine, was 14; the durability in the one being 57′, in the other two 66′; and again, with other gases, in which the condensable matter was as high as 19 and 22, the durability did not exceed 77′ and 81′. In numerous trials I found that the gas from English caking coal gave condensation by chlorine 4·33, and durability 50′ 30″, or nearly so. That

from Wigan cannel coal had condensation as 7·5, but the durability was only 57′; the Yorkshire cannel-coal gas was, condensation 7·66, and durability only 52′ 30″. Had the durability of the English cannel-coal gas kept pace with the condensation test, it ought to have been at least 87′ instead of 52′ and 57′.

It is evident from this that the durability is affected by other circumstances than the presence of the ingredient, whatever it may be, which causes the condensation by chlorine, in other words, than by the illuminating power.

Considering this still farther, I observed a remarkable coincidence between the durability and the specific gravity, as is shewn in the following table :—

Specific gravity, . . .	620	627	645	659	704	740	836
Durability, ...	55′	64′	66′	67′	77′·5″	91′·7″	106′

In the above table it is shewn, that as the specific gravity becomes greater, the times required for the consumption of equal quantities become longer; but the increase of the one does not keep pace with that of the other. There is, however, some connection between them, and on farther investigation it occurred to me, that perhaps the consumption of gases by combustion is regulated by the same law as the diffusion of gases, as pointed out by Professor Graham, viz., that *under equal pressures the diffusion is inversely as the square roots of the specific gravities.* Accordingly, in equal times, the *consumption* should be inversely as the square roots of the specific gravities; and conversely, the *times* for the consumption of equal volumes, from similar burners, and under the same circumstances will be as the roots of the gravities.

Again, if this be true, then, under different pressures, the escape should be as the square roots of the pressures; and, accordingly, the time for equal consumptions should be inversely as the roots of these pressures.

To put this to the test of experiment, I procured a platinum jet, furnished with a graduated pressure gauge, and adapted it to an experimental metre, by which I could consume the gas, under the same and different pressures, and mark the quantity consumed in a given time; and consequently the times for the consumption of equal quantities. The gauge had a vernier fitted to it, by which I could easily read off to one-hundredths of an inch. The temperature and barometer were also noted for each experiment, and the specific gravity, when necessary, was ascertained in the usual way.

The following are the results of trials made for the purpose of putting these opinions to the test.

Consumption of Gases under different Pressures.

Numerous experiments were made for ascertaining this, first with gauges of small diameter, the results of which did not agree

with each other; but when the diameter was about half-an-inch, they more nearly corresponded.

I give the following from among many:—

Burners.	Pressure	Square root of Pressure.	Consum't by Metre.	Consumpt by Calculation.	Difference.
Jet,	4	2	2·2	2·2	...
	8	2·82	3·3	3 3	...
	16	4	4·8	4·4	0·4
Jet,	3	1·73	2 6	2 6	...
	6	2·65	3·6	3·9	0·3
	12	3·47	5·8	5·2	0·4
Jet,	8	2·82	7·01	7·01	...
	16	4	10·511	9·92	0·59
Jet,	50	7·07	5·07	5 07	...
	100	10	7·06	7·07	0·01
	200	14·14	9·64	10·14	0·50

The following are the results with different kinds of burners, the trials having been conducted with the view of ascertaining the illuminating power by these burners:—

Small Fishtail,	34	5·83	1·41	...	...
	77	8·79	2 16	2·13	0·03
Large Fishtail,	48	6·92	2·27	...	...
	97	9 84	3·3	3·2	0·1
Large Fishtail,	50	7 07	2·2	...	...
	70	8·36	2·5	2·6	0·1
Large Batwing,	70	8·36	3·1	...	...
	140	11·8	4·5	4·37	0·13

From the above it will be seen that the escapes are very nearly as the roots of the pressures.

(To be continued.)

Art. IX.—*Mineralogical Description of the Island of Bánká;* by Thomas Horsfield, Esq., M.D.*

After the foregoing geographical description of Bánká, I proceed to a connected narrative of the mineralogical features, in order to explain the constitution of the mines, and to throw some light on the geological history of the island, reserving the most obvious conclusions and reflections until the observations made in different parts of the island have been detailed, and may be taken into one point of view.

But, for the purpose of elucidating the following descriptions, it is necessary to make some remarks or positions of a general nature.

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* From the Journ. of the Indian Archipelago and Eastern Asia, vol. iii, No. vii, 1848, p. 398. The article cited, follows a detailed geographical description of the island.

1. The direction of the island is from northwest, to southeast: in this direction it follows, not only the neighboring island of Sumatra and the peninsula of Malaka, but the large chain of the Asiatic mountains, one of the various branches of which terminates in Ceylon, while another after having traversed Arracan, Pegu, Malaka and probably Sumatra, sends off an inferior range through Bánká and Billiton, where it may be considered to disappear and terminate.

2. It is not only in the direction of its course that Bánká follows the large Asiatic ranges of mountains; the elevated parts of the island, or those which are entitled to be called mountains or hills, have the same constitution as the great chain above mentioned: they are composed principally of *granite.*

3. Next to these, which must be considered as the more important part of Bánká, we meet with a species of rock, which for the sake of distinction I have named red ironstone. It is very extensively distributed and occurs in situations of secondary elevation, in single beds, or in veins of many united together, and covering extensive tracts of country. The red color universally predominates, and it contains a large proportion of iron in its composition; but a more particular account of its distribution and conjunction with other parts of the island, is one of the chief subjects of the following description: the analysis will be added separately.

4. In many parts of the island, these tracts of country, which are composed of red ironstone, are bounded by the *alluvial* districts. These are again subdivided into such as are formed of ranges of waving hills, gradually rising on each other, apparently of prior formation, and such as are completely low and level, of recent origin, and confining the discharge of the large rivers.

5. In conjunction and often within the alluvial tracts are found sandstones, breccias (or puddingstones), and various mixed stones, bearing marks of a comparatively late origin. The former are generally distributed in extensive veins or low ridges; the breccias occur in a great variety of form and disposition. Immense conchoidal or tabular masses, in some instances, cover extensive portions of the ground.

6. Those districts which occur in juxtaposition to the primitive portions, filling the space between these and the fixed veins of red ironstone (iron-rock), or again between these and the alluvial parts, are *stratified:* the strata are uniformly horizontally arranged, and characteristic of the tracts above mentioned, which form the basis of the island.

7. The *ore of tin* is disseminated through these horizontal strata, and, as far as has hitherto been remarked, either immediately under the surface or at no great distance below it; they are mostly found in low situations or near the primitive ridges. The

process of mining has greatly contributed to illustrate their composition; and it is one chief object in the following details to give a clear account of the component parts of the strata, in as far as these were illustrated by the various fragments of stone found at the aqueducts of the mines.

8. Forming part of these strata and distributed through the more solid parts, are extensive masses of *clay* of various colors, from pure white to yellow and red; a black earthy substance which, for the sake of distinction, I have called *black clay*, occurs in irregular masses (with few exceptions) in every mine; and the termination of a stratum is indicated by a peculiar white clayey substance which becomes friable by drying and is called *Kong-tay* by the Chinese.

I have proposed in the mineralogical remarks, to follow the order in which they were made during a tour through part of the Island of Bánká, without any respect to regularity or relative importance; dating the commencement of my investigations from my arrival at Kámpák, in March, after a passage of two days from the settlement of Rángám. In my course around the western extremity of Bánká, during which the vessel remained near the shore, I had a good opportunity of observing the direction and extent of the mountain Mánumbing and its western and eastern appendages, with part of that range which extends from it, to the eastward.

That tract of country which lines the Bay of Jebus between the hills of Pári-pári on the north, and of Mánumbing and its appendages on the south, must be considered as one of the alluvial districts of Bánká; besides several others of less note, the rivers of Sungeibulo, Kámpák, Pálungás and Rámbát pass through it. In proceeding up the river of Kámpák, I remarked numerous rocks projecting beyond the surface.

I examined them at a cluster which forms a small island called by the natives *Bátu-lukut*, about one hundred yards in circumference. The external form of the entire rocks is rather rounded than sharp; the highest project, at the present season, about ten feet beyond the level of the river. The external color of the rock is of a dirty hue; the surface is very unequal and rough, excavated by fissures, crossing each other in various directions, into irregular angles and rhombs, &c., or marked in a similar manner by white streaks or veins. The fracture is intensely white, some portions appearing glistening as pure quartz, others dull and chalky.

When struck with a hammer, it separates at the fissures, which appear on the surface, into irregular fragments. It also frequently follows the direction of the streaks or lines: these are formed of quartz, and are semi-transparent, frequently approaching the nature of rock-crystal. They often separate from the common mass of the

stone into extensive laminæ of unequal thickness from half a line to a quarter of an inch. In many cases, however, they are closely united to the substance of the rock—they appear on the fracture but cannot be separated. This rock is completely siliceous, and exhibits not the least effervescence on the application of the acids.

The village of *Kámpák* is situated about half a mile from the discharge of this river; the banks are here elevated about twelve or fifteen feet above its common level at low water. After some search I discovered a spot where they were exposed by an artificial section; they there consisted of a stratum of red ironstone formed of fragments of various figures, from the size of a pea to that of several inches in length and diameter, disposed in very fine sand, adhering partially by means of particles of clay; they were all rounded at their edges and bore the marks of having been carried down by the stream. Alternating with this stratum, and in some instances immediately under the soil, I remarked extensive masses of clay of a reddish ground, variegated with yellow and white; small fragments of ironstone were often bedded in it.

From Kámpák, the direction of the river is winding through the alluvial plain to its third branch, which leads to the stockade of Jebus; the profusion of vegetation along the whole course, extending completely to the water edge, prevents an accurate examination of the banks; in several places where they were exposed they exhibited a black vegetable mould. The stockade of Jebus is built on the first elevation beyond the level of the river: I examined the fragments of stone which were thrown out in making the ditch which surrounds it; they are of the same kind as those found near the river at the village of Kámpák, small red ironstones all bearing the marks of attrition, corroded on the surface, flat, oblong reniform, variously excavated, perforated and rounded; the fracture exhibited a red or brown oxyd of iron of different shades, the surface was covered with a yellow ochreous crust.*

The country from the stockade of Jebus to the district of the mines is waving and uneven, but as it is completely covered with wood and vegetables, it is difficult to form an opinion of the relative height of the intervening hills, which may more properly be called risings. I noticed thirteen in succession on this tract.

In the descent after the first rising, large rocks of red ironstone projected from the surface, or were dispersed in large fragments on the road. The fracture is very various; in some fragments it is metallic, in others ochreous or mixed; those of the former (the

* The disintegrated ironmasked rocks of the Peninsula are extremely deceptive in this respect, often appearing like water worn gravel, volcanic lapilli, &c.—Ed.

metallic fracture) are of a dark brown color, laminated or cellular, the excavations exhibiting a dark shining surface and resembling a substance which has undergone fusion and suddenly cooled; the ochreous fracture is generally porous and the color intensely red. Both are a rich iron ore, and their analysis and accurate description will be given in the sequel.

The following nine valleys exhibited similar appearance. The red ironstone in great variety; and *sand*, apparently of different colors, from the clayey particles that are accidentally mixed with it; several of them transmit rivulets, others bear the marks of an accumulation of water after rains.

In the ascent after leaving the tenth valley, the road crosses a very extensive layer of *sandstone*. The color, in general, is light blue or inclining to grey; some parts are covered with a yellowish ochreous crust. It is divided or separated by rightlined fissures, which appear on the surface in delicate lines or streaks crossing each other in various directions: when struck, it separates at these lines, in fragments of every variety of configuration, with flat sides and sharp angles, forming squares, lozenges, pyramids and oblique parallelograms in endless variety. The adhesion of its particles, in its natural situation, is not strong and many portions are friable; by drying, it acquires a considerable degree of hardness. On this layer of sandstone I found, dispersed in various parts, loose fragments of a substance purely siliceous, consisting of minute crystals of quartz closely united into a brittle mass, divided and separating by regular fissures, but mostly in planes or slabs with even surfaces. In the eleventh and twelfth valley are dispersed large loose fragments of red ironstone, similar to those above described: they both transmit small rivulets. After the thirteenth descent, follows that district in which the mines are at present worked. Its boundaries and extent cannot be defined, but the most productive strata of tin ore have been found near the central parts of this peninsula, at the junction of the districts of Sungie-bulu, Klâbet and Tengâ, embracing an irregularly oval space, whose longest diameter is about six miles, sending off arms in various directions, particularly towards *Klâbbet-lâmâ* or to the northeast. Towards the north and northeast the plain is surrounded by the ranges of hills above mentioned; in the southwest and south, it unites with the alluvial hills, which stretch obliquely across this part of the island, and its south and southeast extremities extend to that large desert, surrounding the mountain of Mârâs, which has been imperfectly investigated.

This district, upon the whole, is level or variegated with very gentle risings; but like most parts of Bânkâ, it is so completely covered with vegetation, that in no place can a large extent of surface be taken into view at once.

Of all the mines that are worked at present, in this district, those of Jebus or Anten are the most considerable; they are divided, according to their situation, into those of the *Upper-furnace*, and of the *Lower-furnace;* in the former two, and in the latter three large mines are worked at present, besides ten *small* ones distributed through both districts.

The large mines of the Upper-furnace district are those of *Sungie Tàngo* and *Suntày*, and of the Lower-furnace district, those of *Sungie-Bulàk*, *Tàynàm* and *Seàm:* the ten small mines of both districts are those of *Sunko*, *Sunyu*, *Sunsing*, *Sunwad*, *Sunwing*, *Sunhawa*, *Soktjoy*, *Tenpo*, *Assun*, and *Atshey*.

The first mine, near the southern boundary of the district which I examined, was that of Sungie-Bulàk, named after a river of the same name; the ground in the neighborhood has been worked for nearly thirty successive years.

As the manner in which the business of mining is conducted on Bánkà, will be minutely described in the sequel, I shall, at present, only premise, introductory to the description of the appearances which I noticed under the surface, that, in large mines, the ground is perforated by a square or oblong excavation or pit, from which the successive layers are carried out by the workmen until they arrive at the stratum which contains the ore of tin. These strata, as has already been remarked, are all disposed horizontally, and, comparatively, at no great distance below the surface; extensive tracts of ground are thus, in many places, worked and exposed in succession. In this place particularly, where the stratum had been found very productive, I observed the remains of a great number of pits, from which the ore had been extracted.

In the pit on which the workmen were at that time employed, I noticed the following succession of strata:

On the west side.

No. 1. Stratum, black vegetable mould, . . 1 foot.
2. Sand and yellow clay loosely mixed, . 1 "
3. Black clay, an extensive irregular mass unequal in depth, from . . . . . 6 to 8 ft.
4. Coarse white sand, ... 3 feet.

On the north side.

1. Stratum, black vegetable mould, . . 1 foot.
2. Sand disposed in dark colored clay (irregular), 3 feet.
3. Black clay, variegated with narrow strata of yellow clay; irregular massive, . . 5 to 6 ft.
4. Coarse sand, ... 3 "

On the south side.

1. Stratum, vegetable mould, . . . 1 foot.

2. Sand mixed with mould (containing trunks of trees in a recumbent position; and perforated by deep roots), ... 9 feet.
3. Yellow clay in small irregular layers alternating with dark colored sand, ... 1 foot.
4. White clay, ... 6 inch.
5. Black clay massive, ... 1 foot.
6. Coarse sand.

The miners were at this time engaged in carrying out these different strata; they had penetrated nearly fourteen feet below the surface, and from the disposition of the vein of ore, with which they were acquainted by the experience of the last pit, they expected to arrive at it after having descended about six feet more. On the surface remaining exposed from the former works, I observed very large fragments of a glistening white stone consisting of quartz and feldspar mixed nearly in equal proportions. Some of them were more than twelve inches in diameter. If force was applied they separated at fissures into fragments with regular sides. They had remained after the *washing of the ore;* the fragments of stone which remain, after this process, at the sides of the canals or aqueducts, demonstrate clearly the composition of the stratum in which the ore is found, and I made it a rule to examine them in every mine I visited, and to collect specimens of the varieties.

At this place I found, besides the large fragment above mentioned, smaller particles, diminishing gradually to the weight of a few grains of the same kind; they all had a disposition to separate into fragments with regular angles. In some cases the particles of feldspar were in a state of decomposition and formed a white powder resembling chalk; it was not in the least affected on the application of the strong acids. Small crystals of pure quartz were mixed with this white powder.

Besides these, I found at the aqueduct, sandstone in small fragments, resembling that above described. An aggregate stone or conglomerate in laminæ, composed of particles of quartz united by a yellow, ochreous iron-earth; to several of these the particles of tin ore were still found adhering, and irregular fragments and crystals of pure quartz of various shades of color.

In proceeding from the district of the Lower to the Upper furnace one perceives, on the road, the vestiges of many of the old mines; they form a contrast, though by no means a pleasant one, with the abundant vegetation of the island; the places of the small mines present a naked uneven surface, covered with the remains of the former works, to which the shining particles of quartz mixed with the sand impart a peculiar aridity; the place of the large mines is known by extensive chasms alternating with irregular hillocks. It requires however, but a short time in

Bánká, to cover the whole with fresh vegetation, and in a few years the spots where the mines were worked are converted again into forests.

The mine of *Sungei-Tángo*, is the most important of those of the Upper-furnace; it employs more workmen than any other single mine on the island, and produces, in one season, more metal. The stratification of the excavation is very regular; it consists, under the soil, of alternate layers of sand and clay of various colors, between which the black clay occurs in extensive irregular masses. The lowest stratum, containing the ore, had been lately carried out, and was collected in a large heap preparatory to the process of washing.

I collected at this heap a great variety of the stones which had composed the stratum, of which I shall mention only the chief, as the other varieties will be successively pointed out in the description of the mines.

* * * * * * *

[These stones are mainly quartz and feldspar, with the conglomerate and ironstone before described; also]

Large masses of a white substance which is considered by the Chinese miners as an unequivocal indication of the termination of a stratum of ore, the name is *Kongtay*. It is of the purest white color, very light and adheres strongly to the tongue, it possesses all the properties of pure clay; and the manner in which it is found, demonstrates plainly that it is a deposition from water. On this the ore of tin is composed in strata differing in richness and extent, and mixed with the various kinds of stone which are from time to time enumerated in the account of the mines.

The mines of Sungei Tángo, as well as those of Sungei Bulák above mentioned, have been worked for many successive years, and their neighborhood forms the most extensive naked tracts of the country in this part of the island.

Proceeding from here to *Klábbet* the road leads nearly in a western direction through a most luxuriant forest, the soil of which consists of a thick black vegetable mould.

The most important mine in this district is that of *Sinhin*, it employs thirty-two workmen, and is the second in productiveness of those at present worked in Bánká. I found the miners within six feet of the stratum of ore: they were engaged in carrying out the earth from an extensive pit of an oblong form.

On one of the sides I remarked the following succession of strata:

1. Vegetable mould.
2. Black clay in extensive masses abruptly and irregularly interposed between the other strata.
3. Fine whitish sand (with a small proportion of clay intermixed.)

On another of the sides I remarked,

1. Soil.
2. Black clay massive.
3. Sand adhering partially by means of a clayey cement.
4. Pure white sand.

The difference between the two last mentioned layers was very evident: in the third the proportion of clay was very abundant, and united the particles of pure white sand to a mass which became solid by drying. The fourth was a pure sand consisting of minute grains of quartz, most of which were transparent; in distinction from the other, it was perfectly loose without any adhesion of its particles.

The manner in which the black clay is generally interposed or intruded between the other strata deserves some attention, but will more properly be considered elsewhere.

* * * * * * *

The mines of *Sunnie* are situated near the northern boundary of the district of the mines above mentioned. They are of the *large* kind: the workmen had, at the time of my visit, nearly arrived at the commencement of the stratum containing the ore, after having penetrated:

1. A stratum of soil, ... 2 feet.
2. White clay mixed with a small proportion of sand, becoming a solid mass by drying, . . 3 "
3. Coarse sand, consisting chiefly of fragments of crystals of quartz in some places, intervening small masses of clay, ... 2 "
4. Black clay in irregular masses, . . . 2 "
5. Fine sand, dispersed through particles of quartz and fragments of decomposed granite rocks: here the ore commenced to be thinly disseminated through the stratum, the lowest portion of the layer which had been carried out from the last pit adjoining to the present work, had consisted of very large fragments of decomposed granite, through which the ore had been plentifully dispersed. The miners informed me that the vein of ore on which they had been employed for three years, and which occupied the lowest part of the valley, had several times intersected the course of the river which flows through it.

* * * * * * *

On my track from the mines of Sunnie to Mámpáng, I was gratified, for the first time, by the discovery of a rock of granite in its original situation, in the midst of a forest and almost concealed by a thick coat of moss. This directed my attention to the hill Gánten, with its appendages, which was near by the road. I found that the rock which forms the basis of this hill is of the same kind.

In the specimens of granite which I collected from this hill, the mica is, upon the whole, very sparingly distributed; the fragments of quartz are of very different sizes, from that of the smallest grain, to crystals nearly an inch in length; the feldspar is mixed with the other parts in large oblong or rhomboidal fragments which are mostly easily separated, and in many parts occupy the greatest proportion of the mass. In some portions minute particles of schorl are barely perceptible, in some these are uniformly mixed with the substance of the stone, in others none are to be discovered.

* * * * * * *

In all the rocks which I examined, and of which I collected specimens, the mica was, upon the whole, sparingly distributed, and the only occasional admixture was schorl in very small proportion.

The mines of Mámpáng have been opened within the last two years near a small river called *Tengalow*, which discharges itself into the ocean, a little east of Seká: they are situated in the granite district, about one mile from the northern shore of the island. The miners (at the mine *Sunwad*) had met the layer of ore about ten feet below the surface, it was situated in a valley, and pursued nearly the same direction as the bed of the river, which was turned from its course, and employed for the purpose of washing the ore, as an aqueduct.

I noticed the following strata:

1. Soil, ... 2½ feet.
2. A mixture of fine particles of quartz and clay, . 4 "
3. Detached coarse particles of quartz and feldspar with a small portion of clay and some sand, . 3 "
   At the bottom of this stratum the particles of tin ore become perceptible.
4. Coarse fragments of quartz and feldspar with small particles of schorl; this contained the ore of tin: at the termination the workmen produced to me the white friable substance above mentioned, called Kongtay by the Chinese.

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The mines of *Táyu* belonging to Sungie-bulu and those of *Táynám* and *Seám*, are situated at the southwest extremity of the district of the mines, at no great distance from the road. I passed along an extensive aqueduct of the mine of Táyu, which had lately been constructed. Having left the district of the mines, the road leads through a thick forest, the soil of which is a deep, black, vegetable mould. The country is on the whole descending. Besides several extensive veins consisting of fixed rocks of red ironstone, I observed fragments of this stone wherever the stratum of soil was removed by a current of water. In the stockade of Sungie-bulu were collected several large frag-

ments of sandstone, of the same color and constitution as that found at the last mine above mentioned: upon examination I found that they were brought from the foot of the hill Pári-pári, where this stone is found in abundance. I obtained by means of the natives several specimens from their natural situation. The stockade of Sungie-bulu is built in the alluvial district, the confines of which will more accurately be pointed out in future.

* * * * * * *

In the NORTHERN DIVISION of the island of Bánká the hills are divided into two separate ranges, one near the western the other inclining towards the eastern boundary, between which an extensive space remains which is occupied by the Bay of Klábbet.

This bay has, upon the whole, the same direction as the general range of hills, from northwest (or N.N.W.) to southeast (or S.S.E.) it is terminated on the south by the mountain of Márass: in the geographical account, the northern part of the island has been divided into two peninsulas according to the division naturally formed by this bay.

The mineralogical appearances in the western range and its environs having been described, I proceed to the detail of those in the eastern. The rocks which project beyond the surface at the shores of the bay, as well as those dispersed through the entire western portion, are granite: I examined them in my course through the bay at numerous points. The constitution of the islands of Pulo-Klápá, near the points Tánjong-Ru and Tánjong Mántung, which separate the outer from the inner bay, and which nearly meet each other from the west and from the east, is of the same kind: they are both immense piles of granite rocks, similar to those above described, on which vegetation has commenced.

The gradual inclination or meeting of the declivities of both ranges of hills towards the west from the eastern, and towards the east from the western, is evident not only by the excavation which is filled up by the bay, but also by the course and discharge of the numerous rivers from both sides, and which have been accurately enumerated in the geographical description of the island.

I had an opportunity only of examining the eastern confines of the bay. Between the projecting points or promontories of the hills, bounding the outlets of the rivers, there remains a considerable alluvial tract: and the district of the mines, commences towards the sides of the hills from the boundary of the bay.

Beginning in the north near Tánjong Mántung, we meet the outlet of the river of *Pánjie* flowing into the inner bay, a small branch (but which is considerably dilated by the influx of the tide) takes a somewhat northern direction: on this the stockade of Belinyu is built, at no great distance from the promontory

which runs off from the central range and forms the point Tánjong Mántung. Hence I proceeded in a northern direction to the district of the mines.

On leaving the stockade a long extended hill is observed towards the central parts of the peninsula, which was pointed out to me as Gunung Pánjie (or Pántjie), beyond which the highest parts of the Gunung Towing are occasionally observable stretching towards the southeast.

The road on leaving the stockade is slightly ascending, and the country soon becomes waving. About a mile north of the stockade I observed the first granite rocks: they soon became numerous on both sides of the road, and some of them were of considerable size. One in particular attracted my notice. It stood alone, the form was irregularly conical, the top tabular, and the sides, about half way down, regularly excavated by the gradual operation of the descending water after rains.

Most of these rocks, like those at Mámpáng, were porphyritic with feldspar in large parallelograms and squares. On several parts of the road I found loose rounded fragments of red ironstone, similar to those collected in the alluvial districts above mentioned, but I remarked none in situ.

The district of the mines is situated north of the stockade: they have been worked for many successive years, and extensive surfaces remain exposed.

The mine at present worked is at Towállám: the pit was regularly oblong. I noticed at different sides the following strata.

In the south,

1.	Stratum, vegetable mould, ...	1½ feet.
2.	Black clay, massive as observed in the other mines,	8 "
3.	Clay of a grayish color containing a small proportion of sand, ...	4 "
4.	Black clay, irregular massive, . . .	6 "
5.	Coarse sand in transparent grains imbedded in pure white clay, ...	3 "

This extended to near the stratum containing the ore of tin. One of the miners with a long crowbar raised a portion of it and obtained for me some of the ore of tin: they were employed in carrying out the last mentioned stratum.

In the west,

1. Stratum, vegetable mould.—2. Black clay, massive.—3. Sand in clay of a gray color.—4. White sand.—5. Beautiful white sand (of transparent siliceous particles) and clay.—6. Sand imbedded in yellow clay.—7. Sand in dark bluish clay. The last three layers were less regularly horizontal in their disposition than the layers of sand in many other mines; they had considerable inclination.—8. Loose white sand.—9. Yellow sand, col-

ored with particles of clay, but scarcely adhering; on this followed,—10. The stratum of coarse fragments of decomposed granite, and of breccias through which the ore of tin was disseminated.

None of the mines I visited afforded me a more beautiful and distinct view of the succession of the strata, or more explanatory of their arrangement. The pit on which the workmen were employed had been formed with uncommon neatness, and by means of the abundance of the clayey particles, the sides had remained completely regular and perpendicular. The last layer (No 9 just mentioned) of yellow sand, contained delicate streaks of the ore of a black color, (consisting of very minute particles,) which became evident when it was divided by a sharp cutting instrument: these streaks were not completely regular or uniform, some were horizontal, others had a gentle inclination, they indicated the approach of the stratum which next followed, consisting of larger quantities of the ore distributed through the coarser fragments of decomposed granite rocks, which from the appearance of the stones brought up by the last works contain, or are intersected by veins of red ironstone. The stratum on which the miners were now employed was considerably extensive, spreading in all directions round the mine.

Among the substances which remained from former works near this pit I remarked:

1. Large fragments of siliceous rock of the same kind with that described above, found at the mines of Sungie-Bulak.

2. *Kongtáy* or white friable earth, remaining at the bottom of the stratum, near the termination of the tin ore.

3. *Conglomerate breccias*, these particularly attracted my notice: many of the masses had the constitution of the *red ironstone;* others were aggregate. Although I had found numerous loose fragments of the common redstone on the road to these mines, an attentive search had discovered to me none in large or fixed rocks. The fragments which were collected here, shewed plainly that the miners in taking out the stratum containing the ore, had encountered extensive veins: and they informed me that the blocks which I examined, and which were abundantly strewed over the surface, had been taken from some of the latest pits.

They differed in appearance considerably from the red ironstone found in the environs of Jebus and Klábbet. The stone was much more compact and ponderous. The fracture had mostly a metallic lustre, varying in shades of color, but without the cellulosities above mentioned.

It was generally covered with a yellow or red ochreous crust, and some portions are completely converted into a yellow or red ochre; but particles of quartz were in all instances perceived on the solid masses or in the friable portion. Some of the smaller

fragments, and those particularly taken from the aqueducts, were more purely breccias, consisting of coarse siliceous fragments united by a ferruginous cement; to many of these the ore of tin was still found adhering in very minute particles. From Belinyu to Pándjie, the country is on the whole, alluvial. I observed one granite rock projecting from a branch of the river; the stones which have been collected by the inhabitants of Pándjie for various purposes, are explanatory of those found in the neighborhood; they consisted of fragments of granite and of red ironstone. The mines of Pándjie were situated towards the hill of that name, which has been marked on the map.

That part of this peninsula which, bounding the bay in the east, stretches from the stockade and environs of Belinyu and Pándjie towards the foot of the Gunung Márass, is alluvial. The stockade of Lumut is situated in it, a considerable distance up the river of that name and near the eastern confines of this tract; in proceeding to it from the usual landing place, the road passes several elevations which here bound the alluvial plain. These consist of red ironstone in separate rocks and in large veins covering extensive surfaces. Loose fragments are also dispersed on the road. Those rocks which I examined more minutely and from which I collected specimens, were more similar to those of Jebus and Klábbet than those found at the mines of Towállám just mentioned.

They are mostly cellular, and the fracture is partly ochreous and partly metallic: the separate particles of some of them are very ponderous.

These hills formerly contained strata of ore which has been successively extracted; on approaching the stockade the remains of many of the former mines are passed. Here the surface is covered with mixed stones; fragments of granite, breccia and coarse sand, similar to those found at the aqueducts, are strewed on the sides of the road in every direction. From the stockade of Lumut the district of the mines stretches northward, inclining to the west until it meets that of Pándjie and Belinyu.

I commenced the examination of the mines of Lumut about half a mile to the north of the stockade, at one of the small mines which had lately been relinquished. The process had been carried on as usual on a slightly inclining ground. A vertical section exposed the strata of the hill, and the extensive surface below contained the remains of many former works.

On the side of the hill I noticed—

1. (Layer) soil.—2. Sand.—3. Coarse sand, consisting of large particles of quartz.—4. Clay of a reddish color.—5. Coarse sand.—6. Clay.—7. Extremity of the layer from which the ore had been extracted: the fragments which composed it were chiefly siliceous, of the mixed kind above described, consisting nearly of equal proportions of quartz and feldspar combined into a variegated mass.

The succession of strata was very distinctly exhibited in this mine; the lowest was peculiarly characteristic; and afforded me an opportunity of observing a vertical section of the stratum containing the ore in its natural situation; the fragments which composed it could be separately removed; they were of different sizes, from less than an inch to several inches in diameter.

Although it was evident that they consisted of portions of the decomposed or disseminated primitive rocks of the surrounding districts, their present arrangement shewed that they had undergone a revolution, and had been removed out of their natural situation. A considerable proportion of the feldspar was in a state of decomposition, and appeared as a clayey substance; to these the particles of tin ore often adhered. Grains of sand were mixed, but in comparatively small quantity, with the coarse fragments which formed the stratum.

The surface which had been exposed by the successive works of this mine was very extensive; they had been commenced in a low situation, and the productiveness of the stratum had gradually diminished as the acclivity of the hill increased; the miners, supposing it to be near its termination, had given up the work. The stones which remained here resembled those usually found at the aqueducts. The abundance and size of the fragments of red ironstone and pudding-stones shewed here, as at Towállám, that the miners had met with extensive veins of this stone.

The next mine is situated two miles further north; from the chief miner who administers the work, it is called Hopsun. On the road to it, I passed extensive districts which had formerly been worked. Large fragments of ironstone and pudding-stones were abundantly dispersed over this tract; they were mostly detached and had been removed from their natural situation by the process of mining, and by the formation of canals. The veins from which they were taken, had in many instances run near the surface. In this mine I noticed the following strata:

1. Soil.—2. Sand imbedded in clay of a gray color.—3. Black clay.—4. Coarse white sand.

The stones at the aqueducts were fragments of the common siliceous kind, large and mostly of a white color; very few breccias were mixed with them.

In the next mine called Lakuntouw, situated about half a mile east northeast of the last mentioned, I found the strata—

1. Soil.—2. Sand imbedded in whitish clay.—3. Sand in dark colored clay.—4. Sand in beds of variegated colors.—5. Black clay.—6. White sand.

The stones at the aqueducts resembled those found at the last mine; they contained comparatively few conglomerates or breccias; those which occurred resembled those of the mine of Belinyu.

They were ponderous; siliceous particles appeared on the fracture, alternating with portions of a metallic lustre, and the surface was ochreous. A few consisted of minute particles approaching the nature of sandstone.

The mineralogical appearances in the two districts last described, were very similar to those of the western peninsula of this division of the island. This similarity was displayed, not only in the arrangement of the strata, but particularly in their relative proximity to the surface; it likewise appeared in the constitution of the more fixed parts of the island. Various circumstances did not permit me, in this part of the island, to extend my researches to the range of central hills; but the promontories which descend from them towards the west and form Tánjong Mántung, (which I passed in proceeding to the mines of Belinyu,) as well as extensive districts in the neighborhood, are covered with large piles of granite rocks. Numerous veins of red ironstone have been discovered below the surface at the mines of Belinyu, and in the vicinity of Lumut we met extensive hills, composed of them, and which are in immediate conjunction with the alluvial plains above mentioned, bounding the Bay of Klábbet.

The northern portion of this peninsula up to point Tánjong Tádá is completely unknown; nor can I say any thing from personal observation of that tract which bounds the central range of hill on the east, extending from point Tánjong Tuwing to the confines of Sungie-liat; but the information I obtained from various natives at Belinyu and Lumut, tends to shew that many portions of it are stratified like the districts of the mines on the west side of the range of hills; and from trials made during my residence at Bánká, it appeared that these strata contain a sufficient quantity of the ore of tin to encourage an attempt for extracting it. The district of Mápur is in this situation, and it is followed in the south by that of Dsheniáng, in which mines are at present worked that are under the superintendence of Sungieliát. As to the districts of Belinyu and Lumut, it is proved by the daily trials at present instituted to obtain productive situations, that the richest strata have been exhausted in the course of forty years successive mining.

(To be continued.)

SCIENTIFIC INTELLIGENCE.

I. Chemistry and Physics.

1. *An Inquiry into the Amount of Inorganic Constituents contained in Ale and Porter;* by Thomas Dickson, Manchester, late Assistant in the University Laboratory, Edinburgh, (Phil. Mag., Nov., 1848, vol. xxxiii, p. 341.)—The object in view in commencing the series of analyses given below, was to ascertain if a standard could be formed of the nutritive powers of the ales and porters in general use, in order that a correct estimate of their real value as an article of diet might be deduced.

The analyses show, as might have been expected, a very great variety in the amount of their respective constituents, partly arising from the various modifications each brewer finds himself under the necessity of adopting, from local circumstances over which he has no control, or from personal experience, though the main steps of the process are essentially the same throughout.

The ash consists of that portion of the grain, and other substances employed in the process, which is soluble in water; whilst owing to the various proportions of malt and water employed, to the length of time the infusion is continued, to the temperature at which the infusion is made, to the concentration the liquor undergoes in the boiling to which it is subsequently subjected, and to the process of fermentation, the proportional amount of the constituents varies considerably.

The method given by Fresenius and Will for the analysis of ash was that followed in the present instance. The amount of iron has been omitted, as in most of the cases it was altogether wanting; and in the few instances in which it did occur, it was so minute as to be inappreciable, and apparently was only an accidental impurity.

In order to save needless repetition, the analyses have been calculated after the deduction of the carbon and moisture, and are as follows:—

No. I. Scotch ale at 3*s.* per gallon.		No. II. Another variety of Scotch ale at 3*s.* per gallon.	
Potash	24·547	Potash	26·603
Soda	34·429	Soda	35·715
Lime	1·203	Lime	0·555
Magnesia	0·399	Magnesia	0·232
Chlorine	5·095	Chlorine	9·754
Sulphuric acid	2·131	Sulphuric acid	2·272
Phosphoric acid	25·657	Phosphoric acid	20·005
Silica	6·539	Silica	4·864
	100·000		100·000

No. III. Another variety of Scotch ale at 3*s.* per gallon.

Potash	20·925
Soda	53·083
Lime	0·172
Magnesia	0·331
Chlorine	4·283
Sulphuric acid	1·615
Phosphoric acid	12·513
Silica	7·078
	100·000

No. IV. Scotch ale at 2*s.* 6*d.* per gallon.

Potash	22·119
Soda	33·480
Lime	0·862
Magnesia	4·642
Chlorine	6·925
Sulphuric acid	3·214
Phosphoric acid	24·172
Silica	4·586
	100·000

No. V. Another variety of Scotch ale at 2*s.* 6*d.* per gallon.

Potash	15·913
Soda	42·758
Lime	0·707
Magnesia	0·963
Chlorine	10·085
Sulphuric acid	4·657
Phosphoric acid	16·346
Silica	8·571
	100·000

No. VI. Scotch ale at 2*s.* per gallon.

Potash	23·710
Soda	46·085
Lime	1·979
Magnesia	5·650
Chlorine	3·052
Sulphuric acid	0·130
Phosphoric acid	12·049
Silica	7·345
	100·000

No. VII. Another variety at 2*s.* per gallon.

Potash	10·484
Soda	48·394
Lime	0·257
Magnesia	2·269
Chlorine	6·649
Sulphuric acid	5·562
Phosphoric acid	15·333
Silica	11·052
	100·000

No. VIII. Scotch ale at 1*s.* 9*d.* per gallon.

Potash	27·564
Soda	40·520
Lime	1·341
Magnesia	1·633
Chlorine	8·121
Sulphuric acid	7·014
Phosphoric acid	7·923
Silica	5·884
	100·000

No. IX. Scotch ale at 1*s.* 6*d.* per gallon.

Potash	3·162
Soda	58·508
Lime	0·874
Magnesia	1·032
Chlorine	6·450
Sulphuric acid	6·277
Phosphoric acid	17·622
Silica	6·075
	100·000

No. X. Another variety at 1*s.* 6*d.* per gallon.

Potash	29·828
Soda	38·390
Lime	0·740
Magnesia	0·505
Chlorine	5·557
Sulphuric acid	2·773
Phosphoric acid	16·827
Silica	5·380
	100·000

No. XI. Scotch ale at 1*s.* 3*d.* per gallon.	
Potash	31·907
Soda	20·871
Lime	6·694
Magnesia	1·558
Chlorine	9·454
Sulphuric acid	2·665
Phosphoric acid	16·851
Silica	10·000
	100·000

No. XII. Scotch ale at 1*s.* per gallon.	
Potash	17·570
Soda	31·285
Lime	1·536
Magnesia	2·163
Chlorine	8·802
Sulphuric acid	7·072
Phosphoric acid	16·657
Silica	14·915
	100·000

No. XIII. Another variety at 1*s.* per gallon.	
Potash	11·635
Soda	24·862
Lime	0·646
Magnesia	0·064
Chlorine	18·255
Sulphuric acid	14·566
Phosphoric acid	10·925
Silica	19·047
	100·000

No. XIV. Export ale at 3*s.* per gallon.	
Potash	19·418
Soda	37·131
Lime	1·242
Magnesia	0·528
Chlorine	6·559
Sulphuric acid	19·160
Phosphoric acid	5·984
Silica	9·978
	100·000

No. XV. London porter at 3*s.* per gallon.	
Potash	26·357
Soda	21·777
Lime	6·893
Magnesia	0·394
Chlorine	9·133
Sulphuric acid	6·615
Phosphoric acid	20·576
Silica	8·255
	100·000

No. XVI. Another variety at 3*s.* per gallon.	
Potash	31·140
Soda	32·933
Lime	1·514
Magnesia	0·122
Chlorine	6·459
Sulphuric acid	4·637
Phosphoric acid	9·261
Silica	13·934
	100·000

No. XVII. London porter at 2*s.* 6*d.* per gallon.	
Potash	11·938
Soda	24·330
Lime	3·868
Magnesia	0·659
Chlorine	14·528
Sulphuric acid	12·198
Phosphoric acid	19·545
Silica	12·934
	100·000

No. XVIII. Dublin porter at 2*s.* 6*d.* per gallon.	
Potash	32·042
Soda	42·722
Lime	1·543
Magnesia	0·512
Chlorine	6·777
Sulphuric acid	1·574
Phosphoric acid	7·893
Silica	6·937
	100·000

No. XIX. Scotch porter at 2*s.* per gallon.	
Potash	20·883
Soda	38·766
Lime	1·623
Magnesia	0·166
Chlorine	0·151
Sulphuric acid	6·358
Phosphoric acid	18·773
Silica	13·280
	100·000

No. XX. London porter at 2*s.* per gallon.	
Potash	16·032
Soda	50·820
Lime	1·306
Magnesia	0·097
Chlorine	7·420
Sulphuric acid	4·526
Phosphoric acid	10·279
Silica	9·520
	100·000

No. XXI. Another variety at 2*s.* per gallon.	
Potash	22·879
Soda	30·521
Lime	1·335
Magnesia	1·272
Chlorine	10·919
Sulph'c acid	4·973
Phosph'c acid	12·859
Silica	15·242
	100·000

No. XXII. Dublin porter at 2*s.* per gallon.	
Potash	21·382
Soda	24·008
Lime	0·833
Magnesia	1·187
Chlorine	10·097
Sulph'c acid	2·763
Phosph'c acid	19·987
Silica	19·743
	100·000

No. XXIII. Scotch porter at 1*s.* per gallon.	
Potash	18·861
Soda	33·765
Lime	1·344
Magnesia	1·386
Chlorine	11·386
Sulph'c acid	2·177
Phosph'c acid	12·480
Silica	18·601
	100·000

The dried residue of	No.	I.	yielded	4·800 per cent. of ash.
"	"	II.	"	3·395 "
"	"	III.	"	3·797 "
"	"	IV.	"	5·475 "
"	"	V.	"	3·500 "
"	"	VI.	"	4·621 "
"	"	VII.	"	3·595 "
"	"	VIII.	"	4·673 "
"	"	IX.	"	4·152 "
"	"	X.	"	3·885 "
"	"	XI.	"	8·186 "
"	"	XII.	"	7·626 "
"	"	XIII.	"	12·035 "
"	"	XIV.	"	8·666 "
"	"	XV.	"	7·863 "
"	"	XVI.	"	8·822 "
"	"	XVII.	"	6·864 "
"	"	XVIII.	"	5·720 "
"	"	XIX.	"	6·050 "
"	"	XX.	"	9·001 "
"	"	XXI.	"	14·579 "
"	"	XXII.	"	11·113 "
"	"	XXIII.	"	6·054 "

2. *On a New Method for the Detection of Bromine and Iodine;* by Dr. G. L. CANTU, (Chem. Gazette, Oct. 1st, 1848.)—The water to be examined is evaporated to a small bulk; pure carbonate of potash (the absence of bromids and iodids in which, has been ensured by washing repeatedly with alcohol) is then added in slight excess to precipitate earthy salts which may be present. After boiling for some time, the liquid is filtered and evaporated to dryness; the residue is now powdered and digested in alcohol, sp. gr. ·830, which dissolves any bromids or iodids that may be present. The alcoholic solution is evaporated to dryness, and gently ignited to destroy the organic matter which is generally present; a few drops of dilute acetic acid are now added so as to be in slight excess, taking care to neutralize a trace of carbonate of potash taken up by the alcohol. It is now again evaporated to dryness, care being taken not to heat it so much as to decompose the acetate. The residue is finally dissolved in a very little water and mixed with two or three drops of a weak solution of starch recently prepared. This being done, a small portion of the test-liquid which consists of a mixture of ten parts of sulphuric acid of 66° (sp. gr. 1·767), and one of nitric acid of 25° (sp. gr. 1·197), is placed in a glass with a narrow base; the solution of the saline residue is then poured very gently down the side, so as to rest upon the test-liquid without mixing with it. If iodids or bromids existed in the water, and their coëxistence is almost constant, there will quickly appear two zones in the saline solution, one of a clear topaz-yellow sometimes inclining to green, (bromine,) and the other of a blue color, (iodine,) floating above it.

[I have had occasion to employ this test in the qualitative examination of mineral waters, and believe that it leaves nothing more to be desired in testing for bromine and iodine. I may remark in passing, that having had occasion to analyze minutely a great number of saline waters in this country, I have scarcely ever failed to detect these two elements, although the amount of iodine, always small in proportion to the bromine, is often exceedingly minute.] T. S. HUNT.

3. *Researches on the Compounds of Titanium;* by G. M. EBELMAN, (Ann. de Chem. et de Phys., xx, p. 385.)—By passing a mixture of pure hydrogen gas and the vapor of the perchlorid of titanium, through a glass or porcelain tube heated to redness, a new compound was deposited in large dark violet-colored shining scales, much less volatile than the perchlorid, a portion of which undecomposed is deposited in the colder portions of the tube. It is readily decomposed when heated in the air, into oxyd of titanium (titanic acid) and perchlorid. It is deliquescent and yields, with water, a violet-red solution, which when evaporated, evolves hydrochloric acid, and leaves a blue oxychlorid. Ammonia gives in the solution a dark-brown precipitate, which is undoubtedly the sesqui-oxyd; by exposure to the air it becomes black, then blue, and finally white; if air is excluded, hydrogen gas is evolved from the decomposition of the water, and the same changes in color take place. The formation of the blue compound by the decomposition of water shows it to be intermediate between the sesqui- and per-oxyd, (perhaps $Ti_3 O_4$ analogous to magnetic oxyd of iron.) The analysis of the violet chlorid showed its composition to be $Ti_2 Cl_3$. Its solution reduces salts of gold, silver and mercury to the metallic state, and converts the persalts of iron into protosalts, titanic acid being formed.

In the above process, there was besides formed in the tube, metallic titanium, (in greater quantity as the heat was more intense,) and a minute portion of what appeared to be proto-chlorid.

By heating pure titanic acid in a current of perfectly dry hydrogen gas, it experiences a loss in weight equal to half an equivalent of oxygen, and is converted into $Ti_2 O_3$. This oxyd is slowly rendered white by roasting in the air; it is not attacked by any acid but the sulphuric, which dissolves it into a violet liquid. The process for the analysis of titanic iron by heating it in a current of hydrogen, which depended upon the supposition that titanic acid was not deoxydized by the gas, is consequently inaccurate.

By dissolving the sesqui-chlorid in sulphuric acid, a violet red solution was obtained, which evaporated *in vacuo* over lime, gave indistinct crystalline masses of a sesqui-sulphate; the solution reacts like the sesqui-chlorid.

The sulphuret found by Rose, by passing the vapor of bisulphuret of carbon over $Ti O_2$, gave results on analysis approximating to a formula $Ti_2 S_3$, (Ti = 314·7 Pierre.) By passing sulphuretted hydrogen through the perchlorid heated in a retort nearly to boiling, and transmitting the vapors through a tube, heated to faint redness, hydrochloric acid was evolved and a pure bisulphuret was deposited in soft brass-yellow crystalline scales, with a metallic lustre and resembling *aurum musivum*. By exposure to the air it is slowly decomposed with the evolution of sulphuretted hydrogen. The reaction with sulphuretted hydrogen begins below the boiling point of the chlorid, for the sulphuret is in part precipitated as a greenish substance in the bottom of the retort. T. S. H.

4. *On some Volatile Products resulting from the decomposition of Albumen, Fibrine, Caseine and Gelatine, by oxydizing agents;* by Dr. G. Guckelberger, (Chem. Gazette, March 1st and 15th, 1848, from Liebig's Annalen, lxiv, p. 39.)—The admirable researches of Schlieper* on the oxydation of gelatine by chromic acid, led to the hope that the examination of analogous azotized animal substances would afford important results, and with this view the author has submitted those above named to the action of a mixture of oxyd of manganese and sulphuric acid, as well as to the mixture of bichromate of potash and sulphuric acid. His researches have shown the entire correctness of Schlieper's researches, and have moreover afforded many new and important results.

Caseine with oxyd of manganese and sulphuric acid, has given him acetic aldehyde, metacetonic aldehyde, (?) butyric aldehyde, bitter almond oil, formic, acetic, metacetonic, butyric, valerianic, caproic and benzoic acids. With chromic acid, the products were metacetonic aldehyde, (?) bitter-almond oil, and formic acid in small quantities; metacetonic, butyric, valerianic, benzoic and prussic acids, besides the valeronitrile of Schlieper,† and a heavy oil with the odor of cinnamon.

The caseine was purified by solution in carbonate of soda and precipitation by sulphuric acid; it was then dried. One part of this was added to a mixture of 4½ parts of concentrated sulphuric acid, with

* This Journal, vol. v, p. 118. † Ibid.

twice its weight of water cooled down to 104° to 120°. After standing a day to allow the fat to separate, it was mixed with three parts of manganese and thirty of water, and submitted to distillation.

With chromic acid, the best proportions are three of sulphuric acid, two of bichromate of potash, and thirty of water; the caseine is dissolved as before in the acid, and afterwards mixed with the salt dissolved in ten parts of water; the action immediately commences with violence, but is moderated by adding the remainder of the water, and the distillation goes on calmly.

The separation of these bodies was effected by saturating the acids with carbonate of soda and distilling over the neutral products, which were afterwards separated by careful fractional distillation. The salts were decomposed, and the acids first separated by fractional distillation, and afterwards by crystallization of their salts.

The existence of all the acids above named, was proved by careful analysis.

The butyric aldehyde $C_8H_8O_2$, is sparingly soluble in water; it boils at 154°–158° F., and has a specific gravity of ·800 at 59°. It tastes like acetic aldehyde, but soon becomes acid on exposure to the air from the formation of butyric acid; it reduces oxyd of silver when boiled with it, and forms a butyrate; with a solution of nitrate of silver and ammonia, it gives a metallic mirror. It reacts like acetic aldehyde with potash and ammonia, giving with the latter a crystalline compound closely resembling in its properties aldehyde-ammonia. With sulphuretted hydrogen, it yields a base resembling thialdine.

The characters given by the author differ somewhat from those ascribed by Chancel to the butyral obtained by the distillation of butyrate of lime, which he regarded as the aldehyde of butyric acid.

[It is to be observed that the aldehyde of Dr. Guckelberger approaches nearly in its boiling point to that found by calculation, 145°·2 F., while Mr. Chancel found the boiling point of his liquid to be 203° F.]

The supposed metacetonic aldehyde could not be obtained pure; a liquid of an ethereal odor, boiling between 130° and 149° F., gave numbers closely agreeing with the formula $C_6H_6O_2$. Its specific gravity was 0·79, at 59° F.; it became acid by the action of the air, but did not reduce a solution of silver. From the small quantity of it, the author was unable to make a more minute examination.

The products by chromic acid differ from those obtained by the action of sulphuric acid and manganese, in containing valeronitrile and prussic acid, which are azotized substances. Their absence in the former is explained by the fact that these are at once decomposed by an excess of sulphuric acid, into valerianic and formic acids and ammonia. The residue from the process with manganese evolves a great amount of ammonia with lime, while that from chromic acid yields scarcely a trace.

The fibrine and albumen employed were obtained from blood; these substances and gelatine were treated in the same manner as caseine. With manganese and sulphuric acid they all gave the same aldehydes and acids as caseine, without a trace of prussic acid; the relative proportions of these however varied; with chromic acid, the distillates were all rich in prussic acid, and afforded valeronitrile, besides all the

various products obtained from the caseine. There is then, a perfect similarity between the products of the oxydation of all these bodies; the author observed that the amount of volatile products was increased when the organic substances were allowed to digest for some time with the sulphuric acid, which shows that the acid acts by breaking up the compound into different organic groups.

The author observes that he has obtained acetic aldehyde by treating milk-sugar with chromic acid, and that Engelhardt has observed it in the distillation of lactate of copper.

[These researches show an identity between the products of the decomposition of gelatine and the so-called proteine bodies by oxydizing agents; to which is to be added the fact that both of them afford leucine by alkalies and acids, and according to Berzelius, both yield malic (saccharic?) acids, by the action of nitric acid. The difficulties presented in determining the composition of these substances by direct analysis are very great, from the absence of any test of their purity; from their constant tendency to decomposition rendering it impossible to boil them in water, or even dry them without change, and from the presence of variable and often considerable portions of sulphur and phosphorus, which are only in part separated by the action of alkalies. The immense number of analyses performed, and researches which have been made, and the various disputes upon the subject which have vexed the chemical world, have left us no wiser than before.

In a late communication,* I attempted to show that gelatine may be regarded as an azotized derivation of cellulose, dextrine or some isomeric body, and that a formula agreeing at once with the results of its decomposition and the various analyses, is $C_{24}H_{20}N_4O_8 = C_{24}H_{20}O_{20} + 4NH_3 - 12HO$.†

The complete similarity between the decomposition of gelatine and the proteine bodies by deoxydizing agents, suggests the idea that the latter are likewise derivatives of cellulose. The sulphur and phosphorus so variable in their proportions as they are found to be, can scarcely be regarded as Mulder has represented them, elements bearing an equivalent ratio to the oxygen, carbon, hydrogen and nitrogen, while the affinity by which they are retained, tends to show that they still make an integral part of the combination. They are, it appears to me, to be viewed as replacing in part the oxygen and azote of the normal compounds in the same way as minute portions of magnesium or strontium may replace the calcium in calcite and arragonite, or arsenic the phosphorus in pyromorphite. In calculating formulas from analyses, 16 parts of sulphur should then be regarded as equivalent to 8 of oxygen, and 31·7 of phosphorus to 14 of azote. Supposing the normal compound to be equal to one equivalent of cellulose, with three of ammonia minus twelve of water, we have the formula $C_{24}H_{17}N_3O_8 (= C_{24}H_{20}O_{20} + 3NH_3 = C_{24}H_{17}N_3O_8 + 12HO$.‡ The results obtained

* See this Journal, Jan., 1848, p. 70. † Ibid.

‡ The formula of cellulose, sugar, and all the allied compounds, must evidently be regarded then, as C_{24}, &c., if we take the equivalent of hydrogen as 12·5, oxygen being 100; these compounds are well known to be polybasic. The formation of an amide by the elimination of 4HO for one equivalent of ammonia, is analogous to the reaction by which the nitrites are derived from monobasic ammoniacal salt or cyanogen from oxalate of ammonia, constituting the anhydrid amids of M. Gerhardt.

by calculation from this and from Mulder's formula $C_{40}H_{31}N_5O_{12}$, are subjoined.

	Mulder's formula.	Proposed formula.
C	54·92	53·93
H	7·09	6·36
N	16·02	15·73
O	21·96	24·34
	99·99	100·36

The following are some analyses of proteine, albumen and fibrine from different sources. I, Proteine from albumen. II, Albumen, (Mulder.*) III. and IV, Proteine, (Fleitmann.†) V. and VI, Albumen from the flesh-fluid of fowls, (Wiedenbusch.‡) VII, Fibrine, (Mulder.§)

	I.		II.		III.		IV.
C	53·7		53·6		54·1		53·8
H	6·9		7·0		7·13		7·3
N	14·4		15·7		15·94		16·24
O	23·6	24·3	22·3	23·0	21·41	22·12	21·23	21·94
S	1·4		1·4		1·42		1·43	
	99·3		99·3		99·39		99·28

	V.		VI.		VII.	
C	53·05		53·31		52·7	
H	7·10		6·96		6·9	
N	15·82		15·69		15·4	
O	22·29	23·06	22·28	23·07	23·5	24·1
S	1·55		1·57		1·2	
Ash	·19		·19		Ph	·03
	99·22		99·22		99·13	

On comparing these different numbers with each other and with the results of calculation, it will be seen that the proportions vary considerably; these differences show the liability of the substances to change, and also the frequent mixture of a body which seems to be like a fat in composition, containing no azote and little oxygen, while it is richer than proteine in hydrogen, and is perhaps a result of the alteration of the proteine itself. In Mulder's formula the carbon is from one to two per cent. above that yielded by the analyses, while the oxygen falls nearly as much below that obtained in several instances. This is seen still more strikingly if we regard the sulphur as metaleptic of oxygen in the compound, as I have represented it in the formulas. The first and seventh analyses correspond much more closely to my proposed formula, and this in the case of fibrine, is more clearly seen when we correct that for 100 parts, making it C 53·15 O 23·72, which with ·6 corresponding to 1·2 of sulphur, gives O 24·32.

The reaction of proteine with strong hydrochloric acid by which it is resolved into ammonia and humic acid, a product identical with that derived by the action of the same acid from sugar, is explained by

* Chem. Gazette, No. 115, p. 304.
† Ann. der Chem. und Pharm., t. lxi, p. 121.
‡ Ibid, t. lxi, p. 371.
§ This Journal, ii ser., vol. iv, p. 402.

Mulder by supposing the intervention of four equivalents of oxygen; but bodies like the fibrine of VII, and the proteine of I, obviously require no oxygen, but are converted into these products by the simple diamorphosis, or rather we may suppose into glucose or some analogous substance, and ammonia, by the assimilation of 12HO, the former of which is decomposed into humic acid and water, as is the case when a solution of sugar is treated with hydrochloric acid. I am not aware whether the absorption of oxygen in this reaction, has been determined by experiment, but if such is the case beyond that required for the oxydation of the small quantities of sulphur and phosphorus, the humus body cannot contain equal equivalents of hydrogen and carbon, unless formic acid or some more highly oxydized product is formed at the same time. This reasoning is based particularly upon the two analyses of Mulder quoted, which differ somewhat, it is true, from many others given, but the last being that of undissolved fibrine, seems more worthy of reliance than those derived from partially altered products.

If we receive then, $C_{24}H_{17}N_3O_8$ as agreeing best with analysis and as the true formula for proteine, we have at once explained the fact of this metamorphosis by hydrochloric acid, which refers it directly to the same place in the organic scale as cellulose and sugar, (for there appears no evidence that the various derivatives of sugar described as ulmine, sachulmine and humic acid, stand higher in the scale than sugar, 24th family,) while its connection with gelatine in constitution, and the perfect similarity between the products of its oxydation and those of gelatine, related by the formation of aldehyde to sugar, complete the chain of resemblances.

The assimilation of proteine seems to be different from that of gelatine, at least we have no evidence that it is ever resolved into a non-azotized compound and ammonia in the system, which the case of diabetes recorded in this Journal, ii ser., vol. vi, p. 259, seems to establish in regard to gelatine. The view which makes the tissues of the animal body but azotized derivatives of those which composed the vegetable structure, shows most beautifully the simplicity and unity of the plan of nature. T. S. H.]

5. *Phosphorus*, (L'Institut, No. 773.)—M. Schrötter, has ascertained that the red substance formed on the surface of phosphorus exposed to the light, is simply an isomeric transformation of phosphorus. It is produced in the gases hydrogen, nitrogen and carbonic acid gas, when the phosphorus is thoroughly dry; and it is therefore impossible to attribute the change to an oxydation of the phosphorus. The transformation is quite active in a direct light, and it is sensible even with a feeble diffuse light. When phosphorus, before carefully dried, is kept for 40 to 60 hours at a temperature between 240° C. and 250° C., it is transformed in part into phosphorus of carmine red color, which falls as an opaque powder to the bottom of the vessel; and with small pieces in a close vessel, after a prolonged trial, the whole may be changed to the red state. The specific gravity of this amorphous phosphorus when pure, is 1·964 at 10° C., while ordinary phosphorus is 1·840 at 10° C., or if melted 1·88, at 45° C.

The amorphous phosphorus is obtained pure by means of the sulphuret of carbon, which dissolves readily the ordinary phosphorus. It

is unalterable in the air, insoluble in ether, alcohol, naphtha, and chlorid of phosphorus. Spirits turpentine dissolves it slightly at an elevated temperature. It is much less combustible than ordinary phosphorus, and takes fire in the air at 260° C., which is the temperature at which it passes to the state of phosphorus when heated in an inert gas. A solution of boiling potash attacks it, with a disengagement of phosphuretted hydrogen not spontaneously inflammable; but at the same time the phosphorus passes to the black condition indicated by Thenard. According to M. Schrötter, phosphorus will pass to the black modification only after first having assumed the red.

6. *Observations on Manna;* by J. Stettner, (Chemical Gazette, July, 1848, No. 137, p. 261; Archiv. der Pharm., vol. liii, p. 194.)—The author gives the following account of the cultivation of the manna ash and the collection of the manna, from observations made in Sicily during the summer of 1847. The manna ash, *Fraxinus ornus*, in the manna districts of Capace, Cinesi and Fabarotto, where the best manna is obtained, does not form woods, as is generally supposed, but is cultivated in separate plantations. These plantations generally form regular squares, hedged in with *Cactus opuntia*. The trees are planted in rows, and are from 2 to 8 inches in diameter, with stems from 10 to 25 feet high, which from the first shoot are kept smooth and clean. The soil is carefully loosened and kept free from weeds. After the eighth year the trees yield manna, which they then continue to do from ten to twelve years, when they are cut down, and young shoots from the roots trained; one root-stock frequently yields from six to eight new trees and more. For the production of the manna, young and strong shoots are requisite; but they are not tapped before the tree ceases to push forth any more leaves, and the sap consequently collects in the stem. This period is recognized by the cultivators from the appearance of the leaves; sometimes it occurs earlier than at others, and the collection of the manna takes place either at the beginning of July or only in August. Close to the soil cross sections are made in the stem, and in the lowermost sections small leaves are inserted, which conduct the sap into a receptacle formed by a cactus leaf; this is the way the manna *in sorte* is obtained. The incisions are repeated daily in dry weather, and the longer this continues the more manna is obtained. The stems are left uninjured on one side, so that the manna runs down the smooth bark more easily. The next year the uninjured side is cut. The *Manna cannelata* is obtained from the upper incisions, more than forty of which may be counted on one tree. The sap is there not so fat as below, and consequently dries more easily into tubes and flat pieces. After the manna has been removed from the trees, it has further to be dried upon shelves before being packed in cases. The masses left adhering to the stems after removing the inserted leaves are scraped off, and constitute the *Manna cannelata in fragmentis*. *Cannelata*, *Can. in fragm.* and *Capace* are collected at the same time from one stem—the more *Cannelata*, the younger, and the more *Capace* or *Gerace*, the older the stem. In Sicily the latter is designated *in sorte*, and is probably the most active. Dry and warm weather is essentially requisite for a good harvest.

II. Mineralogy and Geology.

1. *Analysis of Ehlite;* by R. Rhodius, (Wöhl. and Liebig's Annal., lxii, 372.)—Ehlite is found by R. Rhodius to consist of oxyd of copper 63·1, phosphoric acid 28·9, water 7·3=99·3. It is blackish olive green in color, and has an uneven fracture. Specific gravity 4·27. It occurs at *Ehl* near Linz on the Rhine, associated with quartz and chalcedony. The composition proves its identity with Libethenite as heretofore supposed.

2. *Analysis of Brandisite;* by von Kobell, (Leonhard und Bronn, Neues Jahrbuch, 1848, p. 217.)—Consists of silica 20·00, alumina 43·22, peroxyd of iron 3·60, magnesia 25·01, lime 4·00, potash 0·57, water 3·60, oxyd of copper and manganese, *a trace.*

3. *On Völknerite, a new Mineral;* by M. Hermann, (Erdm. und March. Jour., xl, 12; Leonh. und Bronn, Neues Jahrb., 1847, 848.)—Völknerite comes from a talcose slate in the district of Slatoust in Siberia, and was named in honor of Captain Völkner. It occurs in 6-sided tabular crystals, with a very perfect basal cleavage, white color, pearly luster, greasy feel, with the specific gravity 2·04. In the forceps before the blowpipe it swells up somewhat, but does not melt; with cobalt it affords a rose-red color. With the fluxes it fuses with effervesence to a colorless glass. *Composition*, alumina 17·75, magnesia 38·59, water 43·76; giving the formula $Mg^6 \dddot{A}l + 15\dot{H}$.

4. *Ceramohalite;* J. Jurasky, (Ost. Blätter für Lit., 1847, No 109, p. 434; Leonh. und Bronn, Neues Jahrb., 1847, 848.)—Ceramohalite occurs in thick druses with iron-vitriol near Königsberg in Hungary. It is in 6-sided tables, affording angles according to Haidinger of 92° and 134°, and belongs to the monoclinate system. It is very soluble, has an acid reaction, and an astringent taste. When heated, it deliquesces, gives out water and becomes finally a porous mass which is easily soluble in heated water, though difficultly so in cold. *Composition*, alumina 14·30, protoxyd of iron 2·15, sulphuric acid 36·75, water 44·60, insoluble residue 2·01=99·81, leading to the formula $\dddot{A}l\,\ddot{S}^3 + 18\dot{H}$.

5. *Feldspar in the "Orbicular Diorite" of Corsica;* by M. Delesse.—The orbicular diorite is a granitoid rock consisting of feldspar and hornblende and occurring in concentric aggregations. The feldspar is translucent and white, with a grayish or bluish shade. Specific gravity 2·737. Its crystals are like those of common feldspar or albite; yet is generally in thin crystalline laminæ. It is easily attacked by hydrochloric acid, which decomposes it completely, the silica separating as a powder. *Composition*, according to the analysis of Delesse, silica 48·62, alumina 34·66, protoxyd of iron 0·66, lime 12·02, magnesia 0·33, soda 2·55, potassa 1·06, water 0·49=100·39. This gives the formula $3\dot{R}\,\dddot{S}i + \dot{R}_3\,\dddot{S}i$. It is a variety of Vosgite, containing however three times as much lime and much less alkali, with a specific gravity about 0·04 less.

6. *On the Products of Eruption at Hecla;* by Dr. F. A. GENTH of Marbury.—The substances from Hecla examined by Dr. Genth were received by him from Prof. Bunsen. The following are the results of some of his analyses.

Lava of Thjorsá.—This lava has a grayish black color and contains chrysolite along with a new feldspathic mineral which Dr. Genth calls *Thjorsauite.* The lava in its mixed state afforded—Silica 49·60, aluminas 16·89, protoxyd of iron 11·92, *trace* of protoxyds of manganese, cobalt and nickel, magnesia 7·56, lime 13·07, soda 1·24, potash 0·20=100·48.

The Thjorsauite afforded silica 48·36, alumina 30·59, peroxyd of iron 1·37, magnesia 0·97, protoxyd of manganese *trace*, lime 17·16, soda 1·13, potash 0·62=100·20, giving the formula $2\dot{R}_3\,\ddot{S}i_2 + 5\ddot{A}l\,\ddot{S}i$. It is supposed to be monoclinate in crystallization like common feldspar, and has a distinct cleavage in one direction. Lustre vitreous, but pearly on a cleavage face. Color white to grayish. Transparent. Specific gravity at 17°, 2·688. Hardness=6. Before the blowpipe in thin splinters it melts to a glass. Dissolves in borax. Insoluble in hydrochloric acid. In composition it is near scapolite whose formula is $2\dot{R}_3\,\ddot{S}i_2 + 4\ddot{A}l\,\ddot{S}i$. The chrysolite of the lava has the specific gravity 3·226.

The Lava of Háls.—This lava has a grayish black color, with an imperfectly crystalline texture. Specific gravity at 5° C.=2·919. H.=5·5–6. Slightly magnetic. Analysis gave silica 55·92, alumina 15·08, protoxyd of iron 15·18, protoxyd of manganese *a trace*, magnesia 4·21, lime 6·54, soda 2·51, potash 0·95=100·39. Dr. Genth deduces the approximate formula $\dot{R}_3\,\ddot{S}i_2 + \ddot{A}l\,\ddot{S}i_2$. It is however a rock consisting of two or more distinct minerals.

Among the other rocks described in this memoir, the lava of 1845 afforded the same formula of composition as the preceding.

The ashes of 1845 afforded silica 56·89, alumina 14·18, protoxyd of iron 13·35, protoxyd of manganese 0·54, magnesia 4·05, lime 6·23, soda 2·35, potash 2·64, which is nearly identical with the lava.

7. *On the Nummulite Limestone of Alabama;* by C. LYELL, (Proc. Geol. Soc., Jan. 9, 1847.*)—Mr. Lyell after stating that the so-called Nummulites Mantelli of Morton was distinguished by Prof. E. Forbes and Lonsdale as a coral near Orbitolites instead of a true Nummulites, cites a note from D'Orbigny, in which this author observes that it is near Orbitolina but pertains to his new genus Orbitoides, and should therefore be called *Orbitoides Mantelli.*

III. Zoology.

1. *Some Notes on Mexican Birds, heretofore not fully described;* by GEORGE A. MCCALL, U.S.A., (Proc. Acad. Nat. Sci., Philad., May, 1848, p. 63.)—*Orpheus curvirostris,*† Swainson.—Length 10 inches,

* See also this Journal, ii ser., vol. iv, p. 186.
† Called by Mexican peasants "Ouitacoche."

5 lines. The bill is curved and rounded on the ridge, the upper mandible slightly projecting; measured on the ridge it is 1 inch 2 l.; the commissure 1 inch 5 l.; its color dusky. Irides bright carmine, of conspicuous lustre; indeed, the eye is a striking feature of this bird. Tarsus rather robust, and 1 inch 5 l. in length; middle toe and nail 1 inch 3 l.

General color above, light hair-brown, fading to ash-color about the head, while towards the tail it deepens to chesnut. The feathers of the back are loose-webbed; and all the feathers at base are slate-color. Chin, throat, breast, belly and vent, whitish; the breast obscurely mottled with light brown. Primaries dusky, edged with white on the outer vanes; greater and lesser wing-coverts hair-brown, also slightly tipped with whitish. Lower tail-coverts hair-brown, broadly edged and tipped with whitish. Tail of twelve feathers, chesnut; the two middle ones loose-webbed, the three exterior tipped with white.

There is little difference between the sexes; the female is perhaps a trifle less in size, and its general markings are more obscure.

O. curvirostris is rather common about Matamoras, (Mexico.) The song of the male is a clear warble, not unlike the native notes of the mocking bird, but he has neither the imitative powers nor the volume of voice of the latter. On the Rio Grande, this bird nested in the hedge rows near the farm houses, and was constantly seen perched upon their roofs, singing with much volubility and all the familiarity of the house-wren.

Columba leucoptera, Linn.; *C. Trudeauii, or Texan Turtle Dove*, Audubon.—This very graceful bird—only one specimen of which Audubon mentions as having been received or seen by him—was exceedingly abundant at Matamoras in May and June, (1846,) large flocks daily feeding in our camp, and with remarkable confidence approaching quite near the tents. But although common in Mexico, I have some doubts as to the propriety of its being denominated a *Texan Dove*, for I never saw it in Eastern Texas, neither did I while on an extensive hunting excursion, which embraced the country along the Nueces river for seventy miles above Corpus Christi, see a single individual of this species, although game of every description was most abundant. Nor did I see one on the whole route from the Nueces to the Rio Grande, until we crossed the latter river *into* Mexico. Mr. Audubon's specimen was, therefore, possibly but a straggler from the neighboring republic.

About the last of June they disappeared from the vicinity of Matamoras, and passed probably into the interior. In January following, I shot a few stragglers, on small streams, near the *Sierra Madre*.

For the table, this bird is far superior to *C. carolinensis*, the breast being larger and fuller, and the meat of quite a delicate flavor. And in its style of flight it resembles *C. œnas* more than *C. carolinensis*.

The female differs but little from the male, except that the metallic reflections on the neck, &c. &c. are less vivid.

2. *Description of new species of Birds of the genera Vidua*, Briss.; *Euplectus*, Sw.; *Pyrenestes*, Sw.; *and Pitylus*, Cuv.; *specimens of which are in the collection of the Academy of Natural Sciences of Philadelphia;* by JOHN CASSIN, (Proc. Acad. Nat. Sci. Philad., June, 1848, p. 65.)—*Vidua albonotata*, nobis.—Shoulders yellow.

Primaries white at their bases, and for about one-third of their length. Greater wing coverts also tipped with white, which, with that portion of the primaries of the same color, forms a conspicuous white spot on the wing. Lesser wing-coverts tipped with brown. All other parts of the plumage glossy black. Bill light blue, at the edges of the mandibles pearly white. Total length (of skin) from tip of bill to end of tail about 6½ inches, wing 3, tail $3\frac{3}{10}$th inches.

Hab. Port Natal, Eastern Africa.

This bird belongs to that group of species which appears to form the genus *Coliuspasser*, Rüppel. From either of these species (*V. flavoptera*, Viell.; *V. macrocerca*, Licht.; *V. axillaris*, A. Smith and others) it may readily be distinguished by the white spot on the wing, and the pearly character of the bill.

Three specimens of this interesting species are included in the many valuable acquisitions of the Academy made through the judicious exertions of Mr. Edward Wilson, who secured them in Paris.

Vidua concolor, nobis.—Plumage entirely black. Bill strong, conical. General form and appearance of *Vidua payanensis*, Gm., (*V. rubritorques*, Swainson,) but the bill is larger, and the tail and wing feathers are broader, with no vestige whatever of the red collar which characterizes that species. Total length (of skin) from tip of bill to end of tail about 12 inches, wing $2\frac{8}{10}$; tail 8½ inches.

Hab. Africa.

Of this species, one specimen only is in the Rivoli collection, without label. It is closely allied to the *Vidua rubritorques*, Swainson, but has the bill larger than either of ten specimens of the latter which I have examined. The entire absence of the red collar is, however, the most striking comparative character.

Euplectes nigroventris, nobis.—Entire upper parts of the plumage bright scarlet, except the wings and tail, which are hair-brown, with paler margins. Cheeks and entire under parts (from the base of the bill) deep black, except the thighs and under tail coverts, which are pale reddish-white.

Hab. Zanzibar.

Total length from tip of bill to end of tail, about 4½ inches, wing $2\frac{3}{10}$ths, tail 1½ inches.

This species, one specimen of which from the Rivoli collection is here described, is more nearly related to *Euplectes flammiceps*, Swainson, than to any other species known to me. From that species, as well as from all others of this genus, in which the bright scarlet plumage predominates, it may easily be distinguished by the uniform deep black of the entire under surface of the body. The inferior tail-coverts and thighs are pale reddish-white in the specimen now described, but I suspect that in the more adult bird, they become scarlet, and also that the wings and tail become darker.

Pyrenestes coccineus, nobis.—Head, neck, rump, upper tail-coverts and flanks, glossy crimson. Upper surface of the tail of the same color, but not so glossy. All other parts of the plumage, brown, some feathers of the back and a few of the wing-coverts margined with red.

Hab. Western Africa.

Total length from tip of bill to end of tail about $4\frac{4}{10}$ths inches, wing $2\frac{3}{10}$ths, tail $1\frac{8}{10}$ths inches.

Very similar in color to *Pyrenestes ostrinus*, (Vieil.) but is much smaller and less robustly organized. The bill especially is comparatively weak. In the species now described the crimson does not extend to the breast as in *P. ostrinus*. The measurements of the two species are as follows:

P. ostrinus, (Viell.)	*P. coccineus*, Cassin.
Total length (of skin) from tip of bill to end of tail about	$5\frac{6}{10}$ths inches.	$4\frac{4}{10}$ths inches.
Length of wing from flexure to tip of longest primary	$2\frac{8}{10}$ths "	$2\frac{3}{10}$ths "
Length of tail	$2\frac{4}{10}$ths "	$1\frac{9}{10}$ths "
Length of bill from gape	$\frac{7}{10}$ths "	$\frac{8}{10}$ths "
Breadth of under mandible	$\frac{7}{10}$ths "	$\frac{5}{10}$ths "

The dimensions of the specimen of *P. ostrinus* here given, agree almost exactly with those given by Mr. Swainson in Birds of Western Africa, (vol. i, p. 158,) and also with Viellot's plate *Ois. Chant.* pl. 48.

For a fine specimen of the rare *Pyrenestes ostrinus*, (Viell.) the only specimen in the collection of the Academy, we are again indebted to Mr. Edw. Wilson, who obtained it in Paris. The Academy possesses three specimens of the smaller species now described, two of which were presented by Robt. McDowell, M.D., Surgeon at Sierra Leone, and the other was presented, with other interesting birds, by Rev. Wesley Johnson, a pious and learned gentleman attached to an American Mission at Monrovia, Western Africa.

Pitylus flavo-cinereus, nobis. *Lovia canadensis*, Linn. variety A. Lath. Gen. Hist. V. p. 282.—Space about the base of the bill extending to the eyes, and including the chin, black. Front and top of the head, sides of the neck, breast, and under surface of the wings at the shoulders, bright yellow, running into green on the neck and back. Upper part of the back, wings and tail yellowish green. Scapular region, lower part of the back, rump, upper tail-coverts, abdomen and under tail-coverts light cinereous gray. Middle of the belly and under tail-coverts nearly white.

Hab. South America.

Total length, of skin, from tip of bill to end of tail about 7 inches, wing 4, tail 3 inches.

I have seen only one specimen of this species, which belonged to the Rivoli collection. It is nearly related to *Loxia canadensis*, Linn., which it strongly resembles in general appearance, but may at once be distinguished by the cinereous lower portion of the whole body above and below, which color is separated from the yellow of the breast by a well defined line, while in *L. canadensis* the entire inferior surface is bright yellow. The bill of the species now described is larger than that of either of eight specimens of *L. canadensis* which I have examined.

3. *Otters in Hadley, Mass.*, (Hampshire and Franklin Express, Nov., 1848.)—A few weeks since, (Sept. last) a pair of young otters were killed in Hadley by Mr. Elijah Cowles. They were in company with two other young and two old ones. The latter had been seen, during the summer, about Smith and Granger's pond in North Hadley;

and on one occasion, being annoyed by the barking of a dog, one of them suddenly leaped from the water, seized the dog, and drew him to the bottom, from whence in a depth of four feet, the dog was rescued by his master. Mr. Cowles met with this interesting family, when they were taking a walk in a grove near Adams' pond. Immediately they arranged themselves in an order favorable both for defense and retreat, one full grown animal being in front and the other in the rear. The latter bravely made fight, and seemed quite insensible to the blows of Mr. C.'s whip-handle. Having no other weapon, Mr. C. was able to kill only two of the young otters, which he has generously presented to the Zoological Museum of Amherst College. It is said to be thirty-five years since any otters have been seen in this immediate vicinity.

IV. Astronomy.

1. *Le Verrier's Remarks on the Planet Neptune.*—At a sitting of the French Academy held Sept. 11, 1848, M. Le Verrier communicated a paper respecting the identity of the planet Neptune with the theoretical planet of his computations. The following translation we take from the *London Athenæum* of Sept. 30.

"It is two years since I discovered the planet Neptune by means of the perturbations produced by it in the motions of Uranus. My earnest solicitations that my labors should be verified by means of a telescope were listened to at Berlin; and on the 23d of September, 1846, was begun, in the Prussian Observatory, the regular series of observations of Neptune.

"I had only arrived at the position of this planet by indirect means, and without having seen it. It was, therefore, impossible that I should have attained as much precision as the direct observations of the star itself would afterwards insure. Since it was necessary that I should make use of irregularities, on which I could only depend to within *a tenth* of their value (as I will hereafter explain, if desired), it would have been natural that this inaccuracy should influence the positions thence deduced for Neptune, and that these positions should be liable to an error of one-tenth. But I shall make it appear that the deviation from my theory is far inferior to this tenth. Hence it will naturally result that all assertions to the contrary are false. Without troubling myself more than necessary with the clamor attempted to be raised on this subject, I think it nevertheless my duty to take due notice of it; for if such an error should *for a time* take the place of truth, it would not fail to discourage deeply all those devoted to the progress of science.

"'The identity of the planet Neptune with the theoretic planet,' says M. Babinet, in his notice of the 21st of August last, 'is no longer admitted by any one, after the enormous differences discovered between them as to mass, period of revolution, distance from the sun, eccentricity, and even as to longitude (except at the epoch of the discovery of M. Galle, or for a very few years before and after).' If I quote this observation by the learned physicist, it is only because it sums up with infinite care all the pretended difficulties. I will go over each in particular, and reduce them successively to their real value. But I shall be permitted not to find a difficulty in the gratuitous assertion that

'the identity is no longer admitted by any one.' I say that after this discussion, no one will hesitate respecting the assertion of M. Babinet (*Personne* ne s'arrêtera au dire de M. Babinet).

"Let us first fix precisely the state of the question. I have determined the position of Neptune by means of the perturbations which it produces on Uranus. Accordingly, when such perturbations take place, I can find directly where Neptune is. But when there are no perturbations, this is impossible. Let this not be forgotten. Again, the action of one planet on another depends, at a given moment, only on its relative situation in the heavens and on its mass. The only facts, therefore, which I could conclude from the perturbations of Uranus, while they existed, were the direction in which Neptune was to be found, its distance from the sun, and its mass. Let us see how I have arrived at the determination of these three quantities.

"First.—*Is it true that the direction in which I have placed Neptune contains an enormous error, except for the epoch of M. Galle's discovery, or for very few years before and after? NO; this is false.* I place before the Academy of Sciences a chart of the respective situations of Neptune, in the orbit I have theoretically assigned to it and in the orbit resulting from direct observation. The latter positions have been taken from Mr. Walker, so as to avoid all suspicion of my having attempted to obtain a smaller deviation. According to this figure, the following are the minimum deviations from my theory:—

In 1857	+ 4°·0
1847	+ 1 ·0
1837	— 0 ·7
1827	— 2 ·0
1817	— 3 ·1
1807	— 4 ·5
1797	— 6 ·6

It follows that *during sixty-five years*, my theory, deduced from indirect considerations, assigns to Neptune a series of positions never differing from those obtained by the direct orbit by more than *one fifty-fifth*, at the most, of the circumference of a circle. And this is called a small number of years, when it is known that Neptune has had a sensible effect on Uranus for only twenty-five or thirty years at the utmost! The *fifty-fifth part* of the circle! This is what is called an enormous error, when it is known that the data which served as basis to my theory are only known to *a tenth*. But I do not insist on this subject, as I hear M. Babinet declare, that when he spoke of *enormous errors*, he had not calculated them, and imagined them much more considerable than they are in reality. But, it will be said, if we go beyond these sixty-five years, we should find more considerable deviations. Yes, without doubt. That results from the nature of the question; it cannot be avoided. I have said that I determine the position of Neptune by means of the perturbations it produces on Uranus. When there are perturbations, I can say where Neptune shall be found; but to ask of me to do so, long after the perturbing action has disappeared, is simply to ask an impossibility—a sort of miracle. Now, in examining my plate—which in a few days I shall place before the public, and in which I have traced the course of Uranus—it appears clearly that this planet

has been influenced by the action of Neptune only from 1812 to 1842,—that is, during only thirty years.

"It is then during these 30 years only that I have been able to determine directly the position of Neptune: and yet the deviation from my theory is only 3°·7 in 1812, at the time when the action of Neptune, which then only commences, was not yet clearly determined. Then, in proportion as this action develops itself, the precision of my indications increases; and in 1842, at length, when I have at my disposal all the action of the planet, I am mistaken by no more than a fifth of a degree only—that is, by an 1,800th part of the circumference—in predicting the direction in which Neptune should be seen.

"Thus, far from reproaching my theory with having made the trifling error of 4°·0 in 1807 and of 6°·6 in 1797, it should rather be asked, how it could give with such precision the position of Neptune at an epoch when it did not act upon Uranus? In fact, this is only obtained by prolonging arbitrarily the curve which I had obtained from 1812 to 1842; a prolongation with which my object had nothing to do (*qui n'est pas de mon fait*) and which is not legitimate when pushed too far. During these thirty years Neptune has performed only a sixth part of its orbit; an ellipse is very ill determined by an arc including only a sixth part of its extent.

"During the whole of the last century, from 1700 to 1812, Neptune has in nowise acted upon Uranus. It has had less influence on it than on Saturn,—which it does not sensibly disturb. When I am required to say, by my theory, where Neptune was in the middle or at the commencement of the last century, I repeat it, a miracle is demanded of me.

"I have then the right to say—It is false that I have committed an enormous error in the longitude at every other epoch but that of Galle's discovery or of a few years before and after. During the whole period that Neptune has acted upon Uranus my theory has not deviated from that deduced from direct observations by more than $\frac{1}{360}$ of the circumference. And now it is said that the discovery made by Galle is a fortuitous accident! Really, then, planets of twice the size of Uranus and yet unknown, although shining like stars of the seventh magnitude, are scattered in such numbers over the heavens that there is nothing surprising if, on pointing by chance to any spot in the firmament there should be great probability of finding one! And it is, no doubt, on account of their numbers, and because there would be no merit in discovering them, that our observers disdain to do so.

"Secondly.—*Is it true that there are enormous errors respecting the distance from the Sun? NO; this is false.* Figures have their eloquence. Here are, according to my plate, the distances from the Sun in the two orbits for the thirty years during which Neptune has acted upon Uranus.—

	Distances in the predicted orbit.	In Walker's orbit after the discovery.
In 1812	32·7	30·4
1822	33·3	30·3
1832	32·6	30·2
1842	32·8	30·1

How is the difference of the two theories to be estimated? In refer-

ence to the distance itself which is to be valued? Whoever, in order to strike the imagination of the public, should express this difference in post-leagues, that is, referring it to the slowness with which we crawl upon the surface of our globe, would be following a proceeding unworthy of an astronomer. Now, in 1812 I have made an error of $\frac{1}{14}$th of the distance, in 1822 and 1832 $\frac{1}{16}$th, and in 1842 $\frac{1}{13}$th; never the *tenth* which I might have reached without being liable to any reproaches.

"The direction was more precise than the distance. This might be,—for if the direction had been false, nothing could have compensated for the error which would have resulted in the attraction of Neptune upon Uranus. Whilst, if the planet be placed a little too far in a given direction, the error, which would result in the quantity of attraction, may be immediately destroyed by making the planet a little larger. This is precisely what has taken place. I placed Neptune rather too far; but I made it rather too large. I might have placed it in any intermediate place, even a little too near, provided I had made it a little too small. But what am I saying? I have made Neptune too large! I forgot that this is a third objection. Let us examine it however.

"Thirdly.—*Is it true that the theoretic mass of Neptune differs from the mass deduced from observations of the satellite, to such a degree as to be an irresistible argument against the identity of the theoretic Neptune with the observed Neptune? NO; this is false.* Let us again have recourse to figures. According to M. Struve the mass deduced from the satellite is $\frac{6.5}{100}$ of the mass I had predicted. But I will grant, if it is insisted on, that $\frac{5.2}{100}$ must be taken; which, however, is only arrived at by choosing from among the different results obtained that which leads to the greatest deviation. I declare that if any one should be misled by this deduction, which corresponds only to a variation of a fifth in the diameter of Neptune, it would only be by keeping out of sight the difficulties of the same kind presented by the masses of the other planets. The mass of Uranus has been also determined by two different methods—by the action of this planet upon Saturn, and by the consideration of its satellites. Well, the second of the values thus determined is only $\frac{1.5}{100}$ of the first. And yet there were forty years of direct observation of Uranus at disposal whilst I had not a single observation of Neptune. And yet the mass only of Uranus was required to be deduced from its perturbations on Saturn, whilst I sought, from those of Neptune on Uranus, the direction, the distance, and the mass of the planet. Will it be said then that there are two planets Uranus? It should, to be consistent. Thus, then, the direction, the distance from the Sun, the mass of Neptune—that is to say, the only three things which might justly be required—are exact in my theory beyond all hope. The Neptune which has been found, like that which I sought, satisfies perfectly the perturbations of Uranus. This great accusation, which has made so much noise, falls back into that nothingness from which it ought never to have emerged. I might stop here. A few more words, however, to show how the public is abused by pretended enormous unheard-of errors held up to it. Around the principal star γ Virginis, and under the influence of its action, revolves another star to which observations, made from 1718 till 1835, an interval of 117 years, had assigned a certain elliptical orbit. Ten years of new observations

had sufficed to make this ellipse be abandoned and replaced by another whose surface is nearly five times smaller than that of the former! Will it be said that the star observed before 1835, is not that observed since that time? Moreover, the two ellipses are by the same illustrious astronomer, Sir John Herschel. I do not know that he has been reproached in his own country for not having drawn from observations more than they contained. And comets! There is a comet whose motions during one part of its path may be represented indifferently by a parabola or an ellipse, whose planes would be inclined at more than 60°. Every one is acquainted with the magnificent labors by which Bessel has determined the distance of a star in Cygnus from the earth. Bessel also determined the error which might be feared in the result he obtained. Now translate this inaccuracy into post-leagues, and you will throw ridicule *(in your way of viewing it)* on a work which is the admiration of the world. The error is 1,000,000,000,000—that is, one billion of post-leagues. I shall conclude by considering the distance of the Sun from the Earth,—which has cost astronomers so much labor, so many journeys, dangers, and almost martyrdom. The measurement of this fundamental element of our system has presented, in the hands of the greatest astronomers, discordances greater than those objected to me. It may be obtained in two ways—by means of Mars, or of the transits of Venus across the Sun. The first method is less precise than the second; but in return it may be repeated as often as desired, while the second can be employed only twice in about 120 years. Mars was the first employed in 1750 by Lacaille and by other astronomers of vast merit. They never found by this means more than 32,271,000 post-leagues for the distance of the Earth from the Sun. And the agreement of the results obtained by repeated measurements gave perfect confidence in this number. Now when the transit of Venus across the sun occurred in 1769, a distance of 38,416,000 post-leagues was obtained by means of this transit. The difference of the two results, 6,145,000 leagues, is simply the fifth part of the former. I will add that the difficulty is not completely resolved at present. I have never had such a difference. Should it not be admitted then, for the sake of consistency, that there are two Suns, as there are two Neptunes, —the Sun of Mars, and the Sun of Venus." * * *

2. *Eighth Satellite of Saturn.*—The eighth satellite of Saturn, which was first noticed by Mr. Bond, of the Observatory at Cambridge, Massachusetts, Sept. 16, 1848, was detected two days later by Mr. Lassell, of Liverpool, with the aid of his large reflector. Both discoverers have agreed to call it *Hyperion*. A full account of the circumstances of each discovery, is given in the Appendix of vol. iii, of the new series of the *Memoirs of the American Academy*.

3. *Elements of Petersen's Comet of Aug.*, 1848, (Institut, No. 770.) —Prof. Schumacher has furnished the following elements of the comet discovered August 7, 1848, by Dr. Petersen, of Altona.

Perihelion passage, 1848, Sept. 8·0560 m. t. Gr.

Longitude of perihelion,	310° 34′ 36″	App. Eqx.
" " ascending node,	211 34 36	Aug. 19.
Inclination,	84 28 22	
Log. of perihelion distance,	9·504875.	
Motion,	Retrograde.	

4. *New Comet.*—On Saturday, Nov. 25, 1848, at 6½ P. M., Mr. Geo. P. Bond, Assistant at the Cambridge Observatory, discovered a telescopic comet in the constellation Cygnus. Its place Nov. 25, $6^h\ 57^m$, was A. R. $20^h\ 35^m\ 11^s$ and N. decl. 37° 21′ 50″.

The following elements are derived from the earlier observations.

	Prof. Peirce.	Mr. G. P. Bond.
Perihelion pass. Gr. m. t. 1849,	Jan. 19·238	Jan. 19·432.
" distance,	0·9526	0·9601
Long. of perihelion,	70° 16′	6° 30′
" " asc. node,	215 46	215 02
Inclination,	84 29	85 13

Motion direct.

At its descending node, the comet passes very near the orbit of the earth.

5. *Comet Medal.*—The king of Denmark has directed the comet medal founded by his predecessor, to be awarded to Miss Maria Mitchell, of Nantucket, for her discovery of the telescopic comet, discovered Oct. 1, 1847. This is the first instance in which the comet medal of the king of Denmark has been awarded to a lady.

6. *Some Remarks upon an American Nautical Almanac*, (communicated for this Journal.)—Encouraged by the recent rapid progress of their science in this country, our astronomers are beginning to aspire to the possession of an ephemeris of their own. This important work will not be undertaken, however, merely as an object of national pride, nor for the sake of being independent of the labors of other countries. As Americans, we naturally wish to see our country among the foremost in the pursuit of science, but her title to distinction will be judged by the intrinsic value and importance of her contributions to science itself, which is "of no country and of no nation." The question, then, which presents itself for consideration, is not simply "shall the United States have an astronomical ephemeris of their own?"—but "does *astronomy* need a new one and a better one than it already possesses?" If the latter question is answered in the affirmative, it will not be doubted that the United States should not fail to improve so good an opportunity of rendering a valuable service to science.

The ephemeris may be regarded as the exponent of the actual state of astronomical science, at least so far as relates to the objects contained in it. It professes to predict for certain given times, the exact places of the principal heavenly bodies, and to furnish for the convenience of both the observer and the computer all the astronomical quantities that are simply functions of the time. To be of any use in enlarging the boundaries of the science, it is plain that every one of these quantities should be given with the greatest possible degree of accuracy; and when a correction has been obtained for any one of them, it should be immediately incorporated into the ephemeris.

Now, that the present ephemerides of Greenwich, Berlin and Paris, do not entirely fulfill these conditions, will appear upon a reference merely to the dates of the astronomical tables upon which they are based. Thus the ephemeris of the sun is prepared from Carlini's Tables appended to the "Effemeridi Astronomiche di Milano per l'anno 1833;" that of the moon from Burckhardt's "Tables de la Lune, Paris,

1834;" Mercury, Venus, Mars, from Lindenau's Tables, 1810–13; Jupiter, Saturn, Herschel, from Bouvard's Tables, 1821. Since these dates, an immense mass of observations has accumulated, from which doubtless important corrections may be deduced for almost every element involved in the construction of the tables. The great work, therefore, which invites the labors of American astronomers is a full revision of these tables, or rather of the theories of the sun, moon and planets, indeed of the whole solar and stellar systems, and the construction thereon of *new* tables which shall bring in all modern observations at Greenwich, Cambridge, Oxford, Edinburgh, etc., in Great Britain; at Paris, Berlin, Pulkova, Königsberg, Munich, Vienna, and many other places on the continent; at Washington and other places in our own country. This would be a work worthy of the nation, and might engage our ablest astronomers and computers.

It will be observed that we do not propose to make an American Nautical Almanac by interpolating the European books to the meridian of Washington, nor by making separate computations from the same tables. Such works would add nothing to the stock of astronomical knowledge and little or nothing to the scientific reputation of the country. Nor do we propose an exclusively nautical work. A complete astronomical ephemeris will of course include what is requisite for the purposes of navigation; but if it were confined to this object it would be of little use to the astronomer engaged in improving the science itself. He requires the extreme of accuracy; the navigator only such a degree of precision as will enable him to determine his position within certain practical limits.

Since such a work as has been described requires the coöperation of the ablest astronomers of the country, some organization is necessary under a superintendent whose scientific character shall command the confidence of mathematicians. For this we look only to the general government. Let Congress authorize the President to appoint such a superintendent, with a certain number of assistants, and let all the salaries attached to these offices be sufficient to command the services of the most competent persons. The national character of the work precludes the idea of confining it to officers already in the service of the government. At the last session of Congress a proposition was made to commence an American Nautical Almanac, under the superintendence of a captain, commander or lieutenant of the navy. Now we do not question the possibility or probability of finding a suitable officer among those grades; indeed, we hail with delight every thing that tends to promote or encourage scientific attainments among them; but we must deprecate the passage of *a law* which would pronounce our professed astronomers, who devote their lives to the science, to be less competent to take charge of important astronomical works than those who by profession are devoted chiefly to other pursuits. It is not to be supposed, indeed, that it was the intention of the originator of this proposition so to pronounce. It was doubtless supposed that a nautical almanac was simply designed for practical use at sea, and that a nautical work could be best prepared only by nautical men; to which it is sufficient to reply, that the ability to use an instrument does not necessarily imply ability to construct it. There might also have been some idea of

economy in employing only those who are already in the pay of the government.

Let us hope that when this subject is again brought before Congress, the proper character of the undertaking will be duly considered, and such a system matured as will unite the labors of *all* our best astronomers, in the navy and out of it, in producing a truly national work, and a worthy contribution to the science of the world.*

V. Miscellaneous Intelligence.

1. *Gold in California.*—It is now several months since the discovery of gold in California, (see vi, 271.) Mines are said to have been known to exist there by the Jesuits; but if so, they had been long forgotten. The first gold was found on a tributary of the Sacramento, called the American Fork, at a point fifty miles northeast of Capt. Sutter's settlement. Capt. Sutter contracted in September, (1847,) for lumber with a Mr. Marshall, and as this place abounded in pine, a sawmill was here built for the purpose. In the course of operations the following spring, the water carried away a large bed of mud and gravel. Mr. Marshall's attention was attracted by some glittering particles at the edge of the mud, and soon satisfied himself of their value. This stream, and others flowing into it, have since afforded large quantities of the precious metal. Weber's creek is the name of one of the streams, and all the ravines emptying into it, as well as its own course, have proved productive as far as examined. Feather river, with its branches Yubah and Bear river, and other eastern affluents of the Sacramento to the North, flowing from the Sierra Nevada, yield gold abundantly; and also, as stated, in the valley of the San Joaquim.

The gold occurs in grains, but occasionally in pieces weighing several ounces. It is found in the sand or gravel of the streams and ravines, and is obtained by washing in the rudest manner. Fifty dollars a day for an individual appear to be a moderate yield, with only a shovel, and a tin pan or wooden bowl for washing; and 250 to 500 dollars a day is not an unusual amount. The sands, after such a coarse operation, must still be of great value for the process of amalgamation. Fortunately the same district, nearer the coast, has just disclosed vast mines of quicksilver, (see vol. vi, 270.) Gold is also stated to be found in the rocks of the mountains.

Governor Mason states in his Report, dated Aug. 17, that about 4,000 men were working in the gold districts, and that from $30,000 to $50,000 worth of gold were daily obtained. The increase since has been great. Assays recently made at the U. S. Mint, at Philadelphia, show a variation in fineness from 892 to 897 thousandths. This is slightly below the standard fineness, which is 906. The value before melting is $18.05½ per ounce, and after melting $18.50.

Platinum is also mentioned among the products of this region.

* It has been suggested that a Nautical Almanac, strictly so called, might be prepared in addition to the general astronomical ephemeris. This may be worth considering in connection with the plan suggested. The larger work might easily be so arranged as to admit of the separate publication of the nautical portions, and in these portions some improvements might be made with especial reference to the convenience of navigators.

Gold is also stated to occur on the eastern side of the Sierra Nevada; and it is reported that the Mormons have found other mines near the Great Salt Lake.

[The writer, when in the region of the Sacramento, in the fall of 1841, (having then journeyed on horseback with a party from Fort Vancouver to San Francisco, and followed down the Sacramento from its source,) remarked the fact that the region resembled other gold districts in its rocks, and has a sentence to this effect in his Geological Report of the country, written out at the time, though but just now being published. The character of the country may occupy some pages in a future number of this Journal.—J. D. DANA.]

2. *Auroral Bow of April* 7, 1847.—About 10 P.M., April 7, 1847, a well defined and bright Auroral bow, spanning the heavens from East to West, and passing the zenith, was seen throughout the Northern, Middle, and Western States. Some account of the phenomenon was given in this Journal, vol. iii, ii ser., p. 440, and vol. iv, p. 145. A description of the same is also furnished by Mr. Daniel Kirkwood, in the *Literary Record of Linn. Assoc. of Penn. College, Gettysburg*, vol. iii, p. 188, June, 1847. The object being isolated, distinct, and regular in its motion, the opportunity for determining its elevation was a most favorable one. Observations were secured by Dr. P. W. Ellsworth, at Hartford, and by myself at New Haven, from which it results that the bow was elevated *one hundred and ten miles* above the earth. The original observations which were for a long time mislaid, are now published in order that all who are interested may be able to determine the value of this conclusion.

(1.) *Observations at Hartford.* N. lat. 41° 45′ 53″; W. long. 72° 40′ 45″

9h 59m 0s	H. m. t.	Southern edge of bow is half way between *Regulus* and *eta Leonis.*
10 0 30	"	"	at *Regulus.*
" 2 30	"	"	at *pi Leonis.*

The times above given were taken by a lever watch of regular movement. This was compared early next morning with a clock which was kept correct by transit observations. The watch was then found 2m. 20s. fast, and may safely be assumed to have varied but a few seconds during the night. The times are consequently to be diminished 2m. 20s.

(2.) *Observations at New Haven.* N. lat. 41° 18′ 33″; W. long. 72° 56′ 45″

9h 54m	N. H. m. t. Bow complete and brilliant: southern edge rather more definite than the northern; both well defined.
56	Southern edge touches *Pollux; Castor* is also within the bow, which is here a little wider than the distance between these stars.
56m 40s	Southern edge touches *mu Leonis.*
57	Northern edge touches *Castor.*
58	Southern edge touches both *epsilon* and *zeta Leonis.*
59	The bow for 10° or 15° each side of the meridian is bent convex towards the North.
10 0 10	Northern limb touches Arcturus; a waving motion is visible within the bow about the meridian; the movement being from E. to W.

10h 2m 0s Bow distinct and brilliant; narrower than before.
2 30 Eastern end begins to disappear.
4 0 Bow irregular in its curvature; serpentine.
5 0 *Gamma Geminorum* in the middle of the bow.
6 0 Bow breaking up into oblique beams. Tall streamers in the North.
8 0 Bow nearly extinct. Northern sky very light.

The observations were taken with a lever watch, which, at 10h. 25m. was compared with a chronometer whose error was known by recent transit observations. The error of the watch thus ascertained, has been applied to the observations, so that they are given above in New Haven mean solar time.

The base line is not so long as could be wished, yet most of the circumstances were uncommonly favorable, and on looking at numerous similar cases I find none which seems to furnish more reliable ground for computation. Making liberal allowances for uncertainties of all sorts, we may be quite sure of the result stated at p. 145 of vol. iv, viz. that this arch or bow "*was elevated not less than* 100 *miles nor more than* 120 *above the earth's surface.*"

This result confirms the general conclusion obtained by Dalton (Philos. Trans. Roy. Soc., 1828, p. 302,) that rainbow-like auroral arches have an elevation of about *one hundred miles* above the earth's surface. It is however quite probable that they differ in height, and that more are above than below the altitude assigned by Dalton. It is not unlikely that they rise as they travel South, but this has never been proved.

Not being able from my position to see the extremities of the bow of April 7, I have no satisfactory means of determining its extent. It was certainly not less than a thousand miles in length, and from ten to fifteen miles in width. Its motion Southward was probably about three miles a minute. E. C. Herrick.

3. *Aurora Borealis*, Nov. 17, 1848.—On Friday night, Nov. 17, 1848, an auroral display of extraordinary magnificence was witnessed wherever the sky was clear throughout the northern portion of our country. At New Haven, where the sky was overcast, the red light was seen through the clouds, and the snow on the earth faintly reflected a rosy hue. The accounts received from various quarters lead us to infer that this exhibition was fully equal to any which is ever seen in this region.

Subsequent to the 17th, the Aurora was visible here every night to the 28th inclusive, except the 20th and 24th, (and the latter night was cloudy;) being sometimes conspicuous, and at other times very faint.

It is reported in the newspapers that the Aurora Borealis of the 17th inst., was seen at Principe, in Cuba, lat. 21° N., and on the 26th at Neuvitas, lat. 21½° N. It is said to have been remarkably brilliant in the N.E. for several hours;—whether on both occasions, or only on the former, is not stated. This is a rare phenomenon in that latitude.

By Scotch and English papers, we learn that an Aurora of unusual splendor was also seen in Britain on the evening of the 17th.

E. C. H.

4. *Relation between the Coëfficient of Elasticity of Metals, and their latent heat of fusion;* by C. C. Person, (Comptes Rendus, Sept. 4, 1848, p. 258.—The expenditure of heat by which molecules are separated in fusion, equals the latent heat of the substance. The author conceived that the work accomplished in this separation should have a simple relation to the work necessary for separating to a less amount. It is already obvious that there is a remarkable relation between the coëfficients of elasticity of metals and their latent heat. It requires double the force to elongate zinc as tin; and it takes an expenditure of twice the heat to melt it. Lead requires five times less force for the same elongation than zinc; and its fusion requires five times less of heat. A similar relation exists between zinc and bismuth, if the zinc be well crystallized.

Designating by q, q', the coëfficients of elasticity of two metals, by l, l', their latent heats of fusion, we have approximately $q : q' :: l : l'$. It is natural that the proportion should not be exact:—$l : l'$ is the relation between the quantities of heat expended in melting the same quantity of two metals; $q : q'$ is the relation between the forces necessary to produce the same elongation in two pieces of metal of the same size and consequently of unequal weights. It is obvious that the latent heat of fusion should be proportioned not to the coëfficient of elasticity, but to a function of this coëfficient representing the work required to destroy the cohesion of molecules comprised in a unity of weights, or at least to reduce this cohesion to what it is in the liquid state. The formula thence becomes

$$\frac{q}{q'}\left\{\frac{1+\frac{2}{\sqrt{p}}}{1+\frac{2}{\sqrt{p'}}}\right\}=\frac{l}{l'}$$

The formula is verified by experiment. For zinc and lead, $\frac{q}{q'}=4{\cdot}80$; the correction, dependent on their densities $(p, p',)$ being made, we have 5·28; but $\frac{l}{l'}=5{\cdot}23$, which is a close approximation. For tin and lead $\frac{l}{l'}=2{\cdot}65$; $\frac{q}{q'}=2{\cdot}20$, and the correction applied gives 2·42. For zinc and tin, the densities being the same, the correction becomes nothing; the relations $\frac{q}{q'}$ and $\frac{l}{l'}$ are equal or nearly so; for $\frac{l}{l'}=1{\cdot}97$; and then, according to the specimens of metals and different modes of vibration, we have for $\frac{q}{q'}$ the values 2·00, 2·09, 2·11, which differ little from 1·97.

If we apply it to platinum and iron, taking zinc for a term of comparison, we find $l=38$ for platinum, and $l=60$ for iron; iron being the most resistant and demanding not the highest temperature, but the greatest amount of latent heat for fusion. Reciprocally, mercury whose latent heat of fusion is so small, offers still less tenacity than lead.

By experiments on cadmium and silver, the author finds the latent heat of the two 13·66 and 21·7; and by the formula 13·52 and 20·38

5. *On the Existence of the Color Brown;* by ERNEST BRUCKE. (From Poggendorff's Annalen, No. 7, 1848, having been read before the Physical Society of Berlin on the 23d of June, 1848; Phil. Mag., xxxiii, 281.)—Brown is wanting in the prismatic spectrum, and its relation to the colors of the spectrum is as yet unknown. Any one may, however, easily convince himself that brown is nothing more than the complementary color to that of Herschel's lavender-gray rays, *i. e.* white light from which these rays have been removed.

For this purpose, separate plates should be split from crystallized gypsum in such a manner that on one side they are as thin as possible, and from it gradually increase in thickness in broad terraces. One of these plates is placed under the microscope, which must be furnished with two Nichol's prisms, one beneath the object-glass, and one in the eye-piece, and so arranged, the prisms being parallel, and the linear magnifying power being about twenty diameters (at a distance of eight French inches), that the above-mentioned thin side is in the field. If it is sufficiently thin, no color is perceived immediately at the side; but as we proceed towards the thicker part, at first a pale brown tint becomes visible, as if we were looking through a very thin plate of horn, and as the thickness of the plate gradually increases in broad and low terraces, the brown continues to become darker until it assumes a deep and pure nut-brown color, without the intervention of any of the prismatic colors which the thicker parts of the plate exhibit.

It is evident that the plate at the margin where it appears colorless is so thin, that the difference of the path of the ordinary and extraordinary ray on their exit does not amount to half the length of a wave for any color. Thus interference of the most refractive rays does not occur until the thickness is greater, and the brown color must therefore be produced by the disappearance of the lavender-gray rays from the compound light.

The correctness of this conclusion is readily tested. On crossing the prisms, it is seen that whilst in the case of all the other colors of the plate the well-known complementary colors appear, that portion which was previously brown becomes colored lavender-gray, and the intensity of this color is in proportion to the depth of the brown previously observed at the same spot.

6. *Inundation of the Indus.* Taken from the lips of an Eye-witness in A. D. 1842. Communicated by Captain J. ABBOTT, (Jameson's Jour., Oct., 1848, xlv, p. 393. Journal of the Asiatic Society of Bengal. New series, No. 188, p. 230.)—Ushruff Khan, Zemindar of Torbaila, states,—"In the month of Poos (December), the Indus was very low. In Maag and Phagoon (January and February), it was so low as to be fordable (an unprecedented phenomenon). In Chayt, it continued very low, but not fordable. In Bysakh (April) the same. About the middle of Jayt (May), the atmosphere was one day observed to be very thick, the air still. At about 2 P. M., a murmuring sound was heard from the northeast, amongst the mountains, which increased until it attracted universal attention, and we began to exclaim, 'What is this murmur? Is it the sound of cannon in the distance? Is Gundgurh bellowing? Is it thunder?' Suddenly some cried out, 'The rivers come!' and I looked and perceived that all the dry channels were already filled, and that

the river was racing down furiously in an absolute wall of mud, for it had not at all the color or appearance of water. They who saw it in time easily escaped. Those that did not were inevitably lost. It was a horrible mess of foul water—carcasses of soldiers, peasants, war-steeds, camels, prostitutes, tents, mules, asses, trees, and household-furniture—in short, every item of existence jumbled together in one flood of ruin; for Rajah Goolab Singh's army was encamped in the bed of the Indus at Koolaye, three koss above Torbaila, in check of Poynda Khan. Part of the force was at that moment in hot pursuit, or the ruin would have been wider. The rest ran, some to large trees, which were all soon uprooted and borne away; others to rocks, which were speedily buried beneath the waters. Only those escaped who took at once to the mountain side. About 500 of these troops were at once swept to destruction. The mischief was immense. Hundreds of acres of arable land were licked up and carried away by the waters. The whole of the Seesoo trees which adorned the river's banks; the famous Burgutt tree of many stems—time out of mind the chosen bivouac of travellers—were all lost in an instant. The men in the trees, the horses and mules tethered to the stems, all sunk alike into the gulf, and disappeared for ever. As a woman with a wet towel sweeps away a legion of ants, so the river blotted out the army of the Raja. There were two villages upon an island opposite Ghazi. One of the inhabitants was returning from Strikote and descending the mountain; when he came within sight of the spot where he had left all he held dear, he naturally looked with affection toward his home. Nothing was visible but a wide-rushing sea of mud. His house, his friends, his household, his village, the very island itself had disappeared. He rubbed his eyes in mortal terror, distrusting his sight, hoping it was a dream. But it was a too horrible reality. He alone, of all that busy hive of moving, struggling, hoping, fearing beings, was left upon the earth."

So far the Zemindar: and to this eloquent description of an eye-witness, I need only add, that it will take hundreds, if not thousands of years to enable time to repair with its healing hand the mischief of that terrible hour. The revenue of Torbaila has, in consequence, dwindled from 20,000 to 5000 rupees. Chuch has been sown with barren sand. The timber, for which the Indus had been celebrated from the days of Alexander until this disaster, is now so utterly gone, that I vainly strove throughout Huzara to procure a Seesoo tree for the repair of the field artillery carriages. To make some poor amends, the river sprinkled gold-dust over the barren soil, so that the washings for several successive years were farmed at four times their ordinary rent. It is generally believed that the accumulation of the waters of the Indus was occasioned by a landslip which blocked up the valley; but this and other interesting questions we must leave for solution to Mr. Vans Agnew, whose late mission to Gilet promises so much to the lovers of science.

7. *Flood in the Macquarie, in Australia;* (Jameson's Jour., Oct., 1848, xlv, p. 395. Lieutenant-Colonel Sir T. L. MITCHELL, Kt., on Tropical Australia, p. 56.)—The talented and energetic Sir Thomas Mitchell, Surveyor-General of New South Wales, in his lately-publish-

ed Travels in Tropical Australia, gives the following graphic account of a flood in the Macquarie :—

"13th February.—I was again laid up with the *maladie du pays*—sore eyes. Mr. Stephenson took a ride for me to the summit of Mount Foster, and to various cattle-stations about its base, with some questions, to which I required answers, about the river and stations on it lower down. But no one could tell what the western side of the marshes was like, as no person had passed that way ; the country being more open on the eastern side, where only the stations were situated ; Mr. Kinghorne's, at Gràway, about five miles from our camp, being the lowest down on the west bank. Mr. Stephenson returned early, having met two of the mounted police. To my most important question—What water was to be found lower down in the river ? the reply was very satisfactory, namely, 'Plenty, and a *flood coming down* from the Turòn mountains.' The two policemen said they had travelled twenty miles with it on the day previous, and that it would still take some time to arrive near our camp. About noon the drays arrived in good order, having been encamped where there was no water, about six miles short of our camp ; the whole distance travelled, from Cannonbà to the Macquarie, having been about nineteen miles. In the afternoon two of the men, taking a walk up the river, reported, on their return, that the flood poured in upon them, when in the river-bed, so suddenly, that they narrowly escaped it. Still the bed of the Macquarie before our camp continued so dry and silent, that I could scarcely believe the flood coming to be real, and so near to us, who had been put to so many shifts for want of water. Towards evening, I stationed a man with a gun a little way up the river, with orders to fire on the flood's appearance, that I might have time to run to the part of the channel nearest to our camp, and witness what I had so much wished to see, as well from curiosity as urgent need. The shades of evening came, however, but no flood ; and the man on the look-out returned to the camp. Some hours later and after the moon had risen, a murmuring sound like that of a distant waterfall, mingled with occasional cracks as of breaking timber, drew our attention, and I hastened to the river-bank. By very slow degrees the sound grew louder, and at length so audible, as to draw various persons besides from the camp to the river-side. Still no flood appeared, although its approach was indicated by the occasional rending of trees with a loud noise. Such a phenomenon, in a most serene moonlight night, was quite new to us all. At length, the rushing sound of waters and loud cracking of timber, announced that the flood was in the next bend. It rushed into our sight, glittering in the moonbeams, a moving cataract, tossing before it ancient trees, and snapping them against its banks. It was preceded by a point of meandering water, picking its way, like a thing of life, through the deepest parts of the dark, dry, and shady bed, of what thus again became a flowing river. By my party, situated as we were at that time, beating about the country, and impeded in our journey, solely by the almost total absence of water, suffering excessively from thirst and extreme heat, I am convinced the scene never can be forgotten. Here came at once abundance, the product of storms in the far-off mountains that overlooked our homes. My first impulse was to have welcomed

this flood on our knees, for the scene was sublime in itself, while the subject—an abundance of water sent to us in the desert—greatly heightened the effect to our eyes. Suffice it to say, I had witnessed nothing of such interest in all my Australian travels. Even the heavens presented something new, at least uncommon, and therefore in harmony with this scene; the variable star η Argus had increased to the first magnitude, just above the beautiful constellation of the southern cross, which slightly inclined over the river, in the only portion of sky seen through the trees. That very red star, thus rapidly increasing in magnitude, might, as characteristic of her rivers, be recognized as the star of Australia, when Europeans cross the line. The river gradually filled up the channel nearly bank high, while the living cataract travelled onward, much slower than I had expected to see it; so slowly, indeed, that more than an hour after its first arrival the sweet music of the head of the flood was distinctly audible from my tent, as the murmur of waters and the diapason crash of logs travelled slowly through the tortuous windings of the river bed. I was finally lulled to sleep by that melody of living waters, so grateful to my ear, and evidently so unwonted in the dry bed of the thirsty Macquarie. Thermometer at sunrise, 47°; at noon, 79°; at 4 P. M., 88°; at 9, 63°—with wet bulb, 57°.

8. *On the Apparent Motion of the Figures in certain Patterns of Blue and Red Worsted;* by HENRY TAYLOR, Esq., (Phil. Mag., xxxiii, 345, Nov., 1848.)—The apparent motion of the figures in certain patterns of blue and red worsted is sufficiently well known to have excited some attention among the learned as well as the unlearned, but, so far as I know, without receiving any satisfactory explanation. After having examined the subject for some time, I believe I have succeeded in making out the cause of this singular phenomenon; and if the following observations are deemed of sufficient importance, I should be glad to have them inserted in the pages of your Journal.

If certain patterns of blue and red worsted-work are examined by candle-light, it is found that when they are moved about, the figures have a tremulous appearance as if they were moving faster than the ground of the pattern—and blue and red are the only colors exhibiting this remarkable property—although it must be observed that some persons are so constituted as not to perceive the illusion under any circumstances.

The usual patterns consist of blue and red figures on a ground of the opposite color, several of them being arranged together on the same piece; but for the purpose of experiment, it is better to have patterns of the simplest kind, and I shall suppose them now to consist of single spots, of red on a blue ground and blue on a red ground.

If the pattern is moved up and down before the eye, and attention is directed to the red spot, we may observe a change of color taking place at its edge, like a dark border or shadow flitting from one side to the other. On close examination, it will be found that as the pattern is moved upward, this dark border appears only at the upper edge of the spot, and but for an instant; as the pattern descends, it is seen again at the lower edge, vanishing as before. When the movement is made from side to side, instead of up and down, a similar appearance may be seen on the right and left of the spot.

If the blue spot is now examined in the same manner, it will present an appearance somewhat different, the borders that form on its edge being of a lighter color than the rest of the spot, and having the effects of lights instead of shadows, as in the former instance.

These changes of tint are so momentary, that they require very close attention in order to be seen at all; and the best way of discovering them is to hold the pattern at some distance from the lamp or candle, moving it at first rather slowly. I have described these appearances thus minutely because they serve, according to my observation, to produce the illusion in question: in them lies the whole mystery.

I conceive that the light and dark borders in the two figures have the same effect on the mind of the observer as the ordinary light and shadow seen on any prominent object that is illuminated from one side; and if such an object could be presented to our view with its light and shade shifting rapidly from one side of it to the other, though without its being moved, I believe we should have an impression that the object really was moving, because we know from experience that such an effect is only to be produced by shifting the position of the candle, or of the object illuminated by it.*

And so it is with the worsted patterns. When we see these spots with their light and dark borders shifting from side to side, we are led to infer that, as the lamp or candle is stationary, the spots themselves actually shift their position, and move faster than the ground of the pattern. Such at least is the illusion; and in some instances the spots will even appear like protuberant bodies rolling from side to side.

In order to prove that this change of tint at the edges of the figures is an efficient cause of the illusion, I prepared a small instrument on this principle. A blue and red spot were affixed to a white card in such a manner that movable shadows might be introduced behind them, which were made to slide from side to side in imitation of the borders of the worsted spots, and to persons not acquainted with the nature of the contrivance the effect was the same, the colored spots appeared to move when their shadows only were being moved.

On the other hand, when the formation of the light and dark borders is prevented, as may be done by inserting a row of white stitches round each of the spots, so as to separate the two colors, then the illusion ceases—the figures are no longer seen to move. The reason of this is obvious, that the presence of the white stitches is an obstacle to the blending of the colors on which the light and dark borders depend for their production. The difference of tint in the two cases may require some further explanation,—why the red spot has a dark border, and the blue a light one. The apparent blending of colors in a state of rapid motion is generally accounted for by the physiological fact, that the eye retains impressions for an appreciable time after the ob-

* I have often convinced myself of the truth of this by a simple experiment. Some prominent body, as a white ball or cylinder, is suspended before an observer seated with his back to a table, on which two lighted candles are placed at some distance apart. By covering up each candle alternately, the light and shadow on the object may be reversed; and if this is done rapidly, it will give it the appearance of moving from side to side.

jects themselves are withdrawn from view; and when a number of objects are presented to the eye in quick succession, the image left on the retina by one object is liable to be confused by that of the succeeding object; and when these are of different colors, a compound color is perceived which is intermediate between the two; but as the spectrum left by the first object is fainter than the image of that which is actually present, it follows that the color of the latter will always predominate. Hence in the blending of the two colors which takes place at the junction of the spot and the ground of the pattern, the resulting tints are different in each case; for the red spot it is purple, that is, the margin of the red spot is seen through a blue spectrum, that of the ground,—while the border of the blue spot appears of a lavender tint, the blue being seen through the spectrum of the red ground. From experiments made with glass of different colors, I venture to suggest this as the probable explanation; for I find that red becomes darker by being seen through a medium of light blue, while the blue is rendered lighter by the aid of a red glass.

These effects are not to be confounded with the phenomenon of "accidental colors," in which the spectrum of an object is of the opposite or complementary color, these colors being produced only when the eye has been exerted upon an object for some considerable time; and, moreover, the complementary colors of blue and red are not perceived at all in these experiments. I mention this distinction, because an attempt has been made to explain the apparent motion of these figures by a reference to the theory of accidental colors.

It remains to be shown why blue and red are the only colors to exhibit this peculiarity. The only suggestion I have to make is, that the intermediate tints formed by the admixture of blue and red contrast strongly with both of the original colors, so as to produce the required effects of lights and shade; and certainly both purple and lavender form decided contrasts with blue and red. And this is not the case with any other combination of the primary colors. For example, the orange tints produced by blending red and yellow contrast too feebly with either of these colors for any effect of light and shade, and the same objection applies to blue and yellow.

Finally, why is the illusion seen only by artificial light? Not from the blue being seen as green (because some degree of motion is observable in blue and red patterns by daylight if they are examined in obscure corners), but from the indistinctness of artificial light as compared with solar light; for it will be found that if the colors are held close to a lamp or candle so as to be strongly illuminated; the effect is destroyed; and on the contrary, it becomes most striking in indistinct lights, as when the patterns are held under cover of the table on which the lamp stands, the shadows on the red spot then become exceedingly dark, while the light tints on the blue spot have almost a phosphorescent appearance. For the same reason, when the pattern is viewed indirectly, the effect is better than when the eye is directed full upon it; and in patterns composed of several spots or figures on their appropriate ground, it is remarked that the apparent motion is greatest in those parts on which the eye is not directed point blank, because our vision is then indistinct.

In connexion with this subject, I may mention another phenomenon equally curious and perplexing, to be observed with these same patterns. The blue spot, when viewed indirectly, always appears lighter than it really is; and when the eye turns full upon it, it resumes its proper color with a kind of start: the red spot again appears much darker by indirect vision, and becomes as suddenly light again when the eye is directed straight towards it. There is no doubt that these changes of tint serve to heighten the illusion of apparent motion when the eye is allowed to wander over the different parts of a complicated pattern. This phenomenon may perhaps be explained by the fact of the sight being most perfect in the axis of vision, or, as Sir David Brewster has expressed it, "the eye has the power of seeing objects with perfect distinctness only when it is directed straight upon them, so that all objects seen indirectly are seen indistinctly;" and it may be supposed that impressions received in those parts of the retina used in oblique vision are, as it were, diffused. Thus the red and blue spots, when viewed indirectly, appear tinged with the prevailing color of the ground of the pattern,—the red spot becoming darker by the influence of the blue round it, and the blue spot lighter by the vicinity of the red; for it is remarkable that this illusion is not produced with single colors, only with spots of one color surrounded by a field of the other.

In concluding these observations, I have only to add, that there cannot be much doubt of the correctness of the view which ascribes the illusory appearance of motion to the change of tint at the edges of the figures. These are matters of fact: but whether the theories offered in explanation of the facts are correct are not, I must leave to more competent observers to determine.

9. *The Tea Plantations in the N.W. Provinces of India, and the Culture of American Cotton in India*, (Jameson's Jour., July, 1848, vol. xlv, p. 191.)—In the Journal of the Agri-Horticultural Society of India, the leading article, which is also the longest and most valuable, is descriptive of the tea plantations in Kumaon and Gurhwal, and of the mode of manufacturing black and green teas. It is from the pen of Dr. Jameson, superintendent of the Botanic Gardens of Upper India, and is drawn up in the shape of a report to the Lieutenant-Governor of the N.W. Provinces. A clearly-detailed and well-arranged paper, we doubt not it will be perused with pleasure by all who take an interest in so important a culture. Apart from the satisfactory view it affords of what has hitherto been effected, it gives much useful information on many other points, and is therefore likely to prove a valuable guide to those who may hereafter be induced to carry out on an extended scale, the work in which the government are now acting the part of pioneers. We cannot undertake to give an abstract of this report, further than to mention, that the nurseries in Dr. Jameson's charge occupy altogether 162 acres, all under culture. Of these, rather more than 30 acres were added during last year. That, in addition to the plants reserved for manufacturing purposes, these nurseries have lately yielded two and a-half lac of seedlings, ready for transplanting at the time the report was furnished, and of which the greater part has been appropriated for the additional land selected in the Dherah Dhoon. A crore and upwards of seeds have again been sown, which will give a large additional

stock for transplanting. About twelve maunds of tea have been manufactured, both green and black varieties, from such plants as were of sufficient size for plucking. This, consequently, does not shew the total amount that 162 acres will yield; because, it must be remembered, that a tea shrub does not come into full bearing before the eighth year, and the oldest of these plantations were established, we believe, only eleven years since, while others have been added to, as mentioned above, during 1847. Perhaps this return scarcely gives one-twelfth of what the yield of nurseries of the present size will be when all the plants have arrived at maturity, seeing that an acre of land, covered with full-bearing plants, should yield a maund of tea in a manufactured state; and this, it is estimated, will not only pay the expense of cultivating, allowing the produce to yield three rupees a seer—by no means a high rate—but give a fair profit to compensate for the loss of interest on capital during the earlier period of their growth. The report gives full particulars regarding the mode of growing the plant, and the proper season for plucking and gathering leaves. The number of hands who are now being trained up in this department, and in that of manufacturing, will prove most useful auxiliaries to the European planter on a future, and, we trust, not distant day; his capital and energy, in combination with their skill and experience, will probably effect a change which can scarcely fail to prove beneficial to all concerned. The introduction of this culture will be the means of encouraging the settlement of Europeans; of throwing a large amount of capital into what is at present a poor country, adding thereby to the comfort of the population generally, especially the agricultural section; and of augmenting considerably the small sum at present yielded to the state, in the shape of revenue, by these hill provinces. Moreover, the advantages arising from the introduction into the markets of Upper India of a wholesome beverage, sufficiently cheap for the consumption of the middling classes of the native community, and for supply to the commissariat, for the use of our European soldiery, are too palpable to need demonstration. In this light alone, the experiments now in progress must be viewed with interest and pleasure. But it is not solely to the provinces of Kumaon and Gurhwal that we have to look. Further inspection has proved the capability of various other spots, immediately to the west of the Jumna, for the culture of this important staple. Moreover, we are informed that, during the present cold season, Dr. Jameson has not only selected many new sites in the Kangra valley, but commenced operations, by the despatch of several hundred thousands of seedlings. Besides this, the fact which we announced some time ago, that the Supreme Government had determined on the establishment of tea plantations along the whole of the mountainous part of the northwest frontier, from the Sutledj and the new country west of it to the Kali, coupled with the circumstance, that an annual grant of a lac of rupees has been lately authorized to carry them on in an efficient manner, prove that our rulers are fully alive to the importance of firmly establishing this culture in Upper India. Should these endeavors prove successful, and private skill and capital be employed hereafter to continue what the state has so happily begun, it is not going beyond the bounds of probability to expect, that, in the course of time, tea, the

produce of our own dominions, will not only compete successfully with that of China in the market of this metropolis, but add another to our list of export articles.

The next paper is contributed by Dr. Robert Wight, superintendent of the government cotton-farms in the Coimbatore District,—*On the Culture of the American Cotton in India, and the proper time for sowing it in various localities.* We had expected a longer and more elaborate paper on a subject of such importance; nevertheless, as the remarks of one having considerable experience of this staple, and possessing an intimate knowledge of physiological botany, we can scarcely doubt they will prove valuable to those engaged in a similar pursuit. Dr. Wight is of opinion, that in his district, as indeed throughout the western coast of the Peninsula, where the N.E. monsoon is usually of short duration, July is the most favorable time for sowing the Mexican variety; while August and September is the best season for localities along the eastern coast, the same monsoon being there of greater force, and extending over a longer period; and that as respects districts subject to the S.W. monsoon, "the last week of May and all June will probably be found the most suitable seasons, the exact time being determined by the individual season and average durations of the rains at each station."

Dr. Campbell, the superintendent of Darjeeling, communicates, in the third article, an experiment which he had instituted on the culture of the tea-plant at that sanatarium, and which promises a favorable result. He thinks it reasonable to expect quite as good tea to be produced there as at Kumaon, and in that opinion he is supported by Dr. Jameson. Darjeeling possesses an advantage over the Kumaon and Gurhwal provinces in point of elevation, being 7,000 feet above the sea. Dr. Campbell promises to report progress. We shall watch it with attention. The introduction of this valuable plant within so short a distance of the metropolis is a matter of no little interest, as connected with the extension of its cultivation.

10. *Expedition into Australia*, (Athenæum, Oct. 7.)—A new expedition into Northeastern Australia is projected for May next, to be under the direction of Mr. Kennedy. The region is called the York Peninsula, visited by Leichhardt, on his way to the Gulf of Carpentaria. Mr. Kennedy proceeds in the Tam O'Shanter to Rockingham Bay, in 18° S., and thence to travel by land to Princess Charlotte's Bay and Cape York, keeping the most convenient distance from the coast. Thence down to the east coast of Gulf of Carpentaria to the water Plaets, to ascertain whether that is the estuary of Leichhardt's river Mitchell, and if so, to follow it up to the junction of the Lynd. The expedition then goes W.S.W. to the river Flinders, for the purpose of ascertaining its source, and from it will attempt to connect the journey with Sir Thomas Mitchell's discoveries in 1846.

11. *Platinum.*—Platinum having been discovered in the Alps by M. Gueymard, the Conseil-General des Mines has authorized researches to be made in that part of the Alps which is on the frontiers of the Department of the Isère. From the nature of the soil, it is expected that deposits of platinum will be found in several localities.

12. *Mines in Australia*, (Adelaide Observer; Athenæum.)—The exports of lead and copper ores from South Australia for the past year (1847), have been declared in a semi-official Report at more than 180,000 pounds. The silver-lead mines of Glen Osmond are being vigorously and successfully prosecuted, and to the productiveness of the contiguous property of Wheal Watkins is about to be added a like productiveness of Wheal Gawler, also adjoining.

13. *The Nile*, (Athenæum.)—Dr. Biallobłotzky is about to undertake an exploring tour into the interior of Africa. His main object is to make one more attempt to settle the disputed geographical question of the position of the sources of the Nile. He was to leave Suez for Aden about the 23d of October, the East India Company having granted him a free passage in one of their steamers. The plan is to proceed from Aden to Mombás on the East Coast of Africa, in about 4° of South latitude, and there, or in its vicinity, make arrangements for travelling into the interior with a native caravan or otherwise. It is anticipated that a journey of 300 or 400 miles from the coast, in a direction between W. and N.W., will bring the traveller to the edge of the table land of Eastern Africa, at the water-parting between the basin of the Upper Nile and that of the rivers Lufidgi, Ozi (Pokomozi or Maro) and Sabaki, flowing eastward, into the Indian Ocean.

14. *A Cabinet of Minerals for sale, collected by the late Dr. Crawe, of Watertown, Jefferson Co., N. Y.*—The cabinet of minerals of the late Dr. Crawe, consists of rare and choice specimens, obtained in part by personal efforts, in part by exchange with gentlemen at home and abroad. It is particularly rich in the northern minerals of New York and Nova Scotia, and contains 1,000 specimens or more. It will be disposed of for a sum much less than its intrinsic value, and may be regarded as an object of moment to public institutions or individuals interested in this branch of science. Enquiries on the subject may be made of Dr. Emmons, of Albany, or Doct. Gray, of Harvard College, Cambridge.

[Although I have not seen the cabinet of the late Dr. Crawe, I have received from him so many and such excellent specimens, that I am well convinced his entire collection must be very valuable, especially in the local minerals of the region which he so faithfully explored.

His specimens of crystallized mica—of crystallized apatite or phosphate of lime, and of fluor spar, have no superiors in this country, nor the two former any equals as far as I know in any country.

Dr. Crawe's zeal for science cost him his life, and his widow and children have strong claims upon its cultivators and upon their country.

B. Silliman.]

Obituary.

15. William Oakes, A.M., well known as the most distinguished botanist of New England, fell overboard from the ferry boat between Boston and East Boston, and was drowned, on the 31st of July, 1848, at the age of forty-nine years. The services which Mr. Oakes has rendered to that department of natural science to which he was so enthusiastically devoted, his active kindness of heart and liberal spirit, which

endeared him to a wide circle of friends and correspondents,—no less than the painful circumstances of his death, in respect to which a misapprehension has obtained currency, which it is the duty of friendship to correct,—all conspire to claim a tribute to his memory in the pages of the American Journal of Science. The writer regrets that the materials at hand for a biographical notice of his lamented friend are so scanty. There are, no doubt, many interesting reminiscences which might be furnished by the surviving companions of his earlier years. But the life of the naturalist who, instead of gathering the novelties of far distant regions, consecrates himself to the assiduous and complete investigation of the flora and fauna of his native district, is seldom eventful. The story of the life of William Oakes may be told in few words. He was born at Danvers, Massachusetts, on the first of July, 1799. He received his earlier education in the common schools of his native town, with the exception of a few months passed, while preparing for college, under the tuition of the late Benjamin D. Oliver, Esq., then a practicing lawyer at Danvers. He entered Harvard College in the year 1816, and was graduated with credit in 1820. His fondness for natural history, which he brought with him to college, was developed under the instructions of the late Professor Peck, and his vacations, and probably no small portion of his time while in college, were given to those studies which were to form the favorite occupation of his life. After his graduation, he spent two years at Cambridge as a law student. The next year he studied in the office of the late Hon. L. Saltonstall, at Salem. On the completion of his professional studies, in January, 1824, he removed to Ipswich (where he resided until his decease), and commenced the practice of law. This, however, he entirely abandoned in the course of two or three years, and devoted himself, with characteristic ardor, to the more congenial pursuit of natural history in all its branches, and especially of botany, which was from the first his favorite department, and in which he was already a distinguished proficient.

Mr. Oakes, although interested in every department of the science, early restricted himself to New England as the particular field of his labors, and seldom, if ever, herborized beyond its limits. There is scarcely a New England plant that he has not collected with his own hands, and prepared an abundance of surpassingly excellent specimens, and also subjected to a critical examination in a fresh state, the results of which were carefully recorded for future use. As early as the year 1830, he had already explored the alpine region of the White Mountains of New Hampshire, in conjunction with his friend Dr. Pickering; and had projected a Flora of New England, to be arranged according to the Natural System, with a Linnæan artificial key to the genera. The appearance of Dr. Beck's Botany of the Northern States in 1833, upon a similar plan, caused him to abandon his own undertaking for a time; but he afterwards resumed the scheme with increased ardor and upon a more elaborate scale. All his explorations, and his special undertakings converged upon this, as the principal work of his life. Towards this he had unweariedly amassed an immense store of materials, and if his premature death has left them in a state which shows little progress made towards their final elaboration, this is to be attributed

not to any lack of industry or perseverance, but to a too fastidious taste, and an over anxious desire not merely to satisfy the ever increasing demands of the science, but to realize his own high standard of perfection. Indeed such were the characteristics of his mind in this respect, that he was never satisfied with any thing done as well as it reasonably could be at the time; and in consequence every piece of work that he undertook grew rapidly under his hands until it became well nigh impracticable. This infirmity, if such it may be deemed, is one with which every naturalist, who feels bound to do justice to his themes, can sympathise. It is but too well illustrated in Mr. Oakes's case by the particular undertaking which occupied his latest years, and from the midst of which he was so suddenly removed. In the autumn of 1842, he was solicited to prepare a brief sketch of the botany of the White Mountains, with a catalogue of their alpine plants, to be appended to the Final Report of the Geological Survey of the State of New Hampshire. Although he had repeatedly explored the mountains, and made their botany a special study in view of his projected New England Flora, he insisted upon visiting once more those favorite haunts before committing his remarks upon their botany to writing. The consequence was that new problems were presented much faster than they could be solved. The subject expanded in magnitude as it rose in interest. One exploration led to another, and a large part of every succeeding summer until the last, was untiringly devoted to these favorite investigations, and to the collection and preparation of literally *hundreds* of specimens, such as he alone could make, of nearly every species that inhabits those mountains, from the forest trees which cover their sombre slopes to the low alpine flowers and mosses that cushion their woodless summits, and the hoar rock-lichens that speckle their topmost crags. The space of a substantial volume was now requisite to do justice to the enticing subject; and the plan was enlarged accordingly. The Geology, Mineralogy and Zoology of the mountains claimed their share of attention; an excellent artist was employed in making drawings of characteristic plants, and finally of phytostatic views and illustrations of the scenery, of rare faithfulness and accuracy. As it became desirable to complete and publish these illustrations separately, in advance of the general work, to which they were at first intended as an appendage, but which they now threatened to overwhelm, Mr. Oakes devoted his attention and all his available resources to having them properly lithographed and published. After surmounting difficulties, one after another, which would have driven any less resolved man to utter despair, after cancelling plate after plate which did not fulfill his expectations, Mr. Oakes had just succeeded in completing them, had sent the last sheet of the text to the printer,—and moreover had just been perfectly relieved from a temporary pecuniary embarrassment in which it had involved him,—when, in a mysterious Providence, he was suddenly removed from the scene of his labors at the very moment they were crowned with success!

To detail the circumstances of the casualty by which a family circle was bereaved of a fond husband and father, while society lost an estimable member, science an ardent votary, and many a naturalist a warm and trusty friend, would not under ordinary circumstances be

either fitting or needful. But in this case, justice requires that his memory should be retrieved from the mistaken judgment of a hasty inquest, by a simple statement of the particulars of the melancholy occurrence, as they have been carefully collected by a friend of the deceased, and communicated to the writer of this notice. It appears, in brief, that Mr. Oakes had been unwell during the previous week; that he was occasionally subject to sudden attacks of vertigo; that he was indisposed and took no breakfast on the morning of the 31st, but left for Boston in an early train of cars to arrange some business there, and return if possible by the eleven o'clock train; that he was much exhausted by walking and by the heat of the day; that he stopped, only a few minutes before the starting of the ferry-boat, at a store near the head of the wharf leading to the depot, to purchase some shot for gunning; that, although he had but a few moments to spare, he took particular pains and trouble to select the two sizes of shot which he was accustomed to use, taking six pounds of one sort and four of another; that, the bell ringing while he was making his purchase, he hurried with it to the depot; that he there met the gentleman whom he came to Boston to see, and received from him the answer he had been led to expect in regard to a business transaction between them, and which precluded all pecuniary anxiety; that he hastily tied up his two packages of shot in his pocket handkerchief, hung it upon his arm, for convenient carriage, and stepped on board the boat just as it was leaving; that, soon after the boat was out of the dock, he was observed standing or sitting at the stern, which was unprotected by a barrier, and the next moment he was seen in the water, where he sank before any effectual means could be used for his rescue. Under these circumstances there is every reason for believing that, in his exhausted state, he was seized with sudden faintness or vertigo, and fell overboard from the stern of the boat; an accident which was the more likely to occur, from the fact that he was very heavy, and awkward in his movements.

It is manifest from what has already been remarked, that Mr. Oakes's services to American botany, are not to be measured by the amount of his actual publications. These consist, principally, of a *Catalogue of the Plants of Vermont*, contributed to the "History of Vermont, Natural, Civil, and Statistical," by Zadock Thompson; and of two or three articles contributed to Hovey's Horticultural Magazine, comprising descriptions of new plants of New England, or notices of new localities, detected by himself or his friend Dr. Robbins. These are but small indications of what he might have accomplished. But there are few botanists in this country who are not indebted to him, directly or indirectly, for some portion of their knowledge, or for some of the finest specimens in their herbaria; and there is no treatise, and scarcely an article on the botany of the Northern States, published within the last twenty years, to which he has not in some way essentially contributed. The immense collections of most beautiful specimens, which he made with peculiar skill, were never hoarded, but were freely bestowed upon every botanist, upon every amateur indeed, who desired, or who could appreciate them. When they accumulated in large quantities upon his hands, it was only because he was not yet prepared to distribute them in the form which seemed most fitting, nor yet able to

enhance their value as he wished, by perfectly authenticating their names. More than once has he placed interesting collections in the hands of the writer, for foreign distribution, perchance among strangers who had never heard his name, expecting no return, other than the satisfaction of knowing that they would be useful. When a botanist who then knew him only by a casual correspondence, lost his whole herbarium by fire, Mr. Oakes's prompt letter of sympathy was accompanied by the substantial encouragement of a fine package of plants, with which to commence the restoration, as well as with most cordial proffers of further assistance.

Mr. Tuckerman has consecrated to the name of Oakes, already inseparably connected with New England botany, a beautiful and highly interesting evergreen, newly detected in several localities along our eastern coast, (the OAKESIA CONRADI, *Tuckerm.*, which is finely figured in the volume of the Memoirs of the American Academy, now just published;) but even if that genus be superseded, his name will not perish from among us, nor the memory of his many virtues, of his active liberality, his manly and disinterested zeal, his untiring devotion to science, and his pure love to the objects of his study for their own sake. A. GR.

16. *Death of* ROBERT GILMOR, Esq., *of Baltimore.*—We cannot permit one of our earliest and most constant friends to pass away without a brief tribute to his memory. His death took place in Baltimore on the 30th of November, at the age of seventy-four or seventy-five.

Mr. Gilmor was one of the first to second and by his influence and kindness to sustain our efforts in those departments of science in which we have labored.

He early attached himself to the cultivation of mineralogy, and his affluence and extensive personal acquaintance with eminent mineralogists in Europe, and his travels in various foreign countries as well as his intimate intercourse with our rising mineralogists at home, enabled him to collect a cabinet remarkable for its richness in fine and rare minerals; for he selected his specimens with the spirit both of a man of science and of an amateur. The notice of his cabinet in our last number was communicated by himself, and the other treasures of his richly endowed mansion made it a beautiful museum for science, literature and the arts. His collection of autographs is distinguished not less by its extent than by its high value. Mr. Gilmor moved in the most elevated circles in Europe and had access to literary treasures, some of which are very peculiar. He was for many years a sufferer with the asthma, but his energetic and animated spirit, by God's blessing, sustained him to a good old age, cherished, admired, revered and beloved by a wide circle of friends. He was a fine example of a gentleman of the old school; polite, cheerful, frank, affectionate, hospitable, and liberal both with his money and his influence. He was a decided supporter of the religious and moral institutions of Christianity, and of all good and benevolent efforts.

His father, a native of Scotland, but long established in Baltimore, sustained and transmitted to his son a high standing as a merchant and banker. Louis Phillippe and his brothers drew their funds from this banking house when they left Baltimore on horseback for the west-

ern wilds,* and during their wanderings in America they referred to the house of Gilmor.

17. Dr. SAMUEL GUTHRIE, died near Sackets Harbor, on Thursday evening, Oct. 19, aged sixty-six. The deceased was endowed with intellectual powers of a high order, and was a devoted student of nature. He was eminent in his profession, while engaged in its practice; but for many years previous to his death, had been occupied with other pursuits. Being the original inventor of the percussion powder, and the only manufacturer of that article in the United States, much of his time had been employed in superintending its preparation—and while thus occupied, he had on several occasions narrowly escaped with his life, receiving severe injuries from which he never entirely recovered.

The honor of first procuring chloroform is shared by him in common with Soubeiran of France, and Liebig of Germany. These three chemists without any concert of action, or knowledge of each other, procured it about the same time. The question of absolute priority has not been conclusively established, but a committee of the Medico-Chirurgical Society, of Edinburgh, awarded to the deceased the credit of having first published an account of its therapeutical effects as a diffusible stimulus, in 1832.

A love of the natural sciences was predominant in his mind, and he eagerly perused whatever had reference to *facts*, and *demonstrations* as a basis; entertaining at the same time, a feeling bordering on disgust for mere *assumptions*, *conjectures* and *speculations*. Chemistry was his favorite study, and he is chiefly known to the scientific world through his contributions to this Journal,† and the "Scientific American;" while in connection with *Chloroform*, his name is familiar in both hemispheres.

His reading was varied and extensive; embracing nearly every department of knowledge and literature, except works of fiction, for which he had no taste. He was a constant and attentive reader of the medical periodicals of the day, and took a lively interest in everything pertaining to the progress or improvement of medical science. He had suffered severely from bodily infirmities for years, but his mental vigor continued to the last—and many who knew him, can bear testimony to the kindness of his disposition, and the generosity of his nature.—*Sackets Harbor Observer.*

18. Dr. A. GOLDFUSS.—The death of Dr. Goldfuss, the author of the great work on Fossils, has been recently announced. His age was 66.

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* As mentioned to the writer by Mr. Gilmor.

† The following is an enumeration of the articles contributed to this Journal by Mr. Guthrie:—

On a mode of obtaining chloric ether, volume xxi, 64, and xxii, 105.

Vaporization of Mercury in the fumes of Nitric Ether, vol. xxi, 90.

Chemical Products:—Manufacture of Chlorate of Potash and a percussion powder—Molasses from the Potato—Gunpowder—Pure Spirits of Turpentine, vol. xxi, pp. 92-94.

Sugar from Potato Starch, vol. xxi, p. 284.

Fulminating Preparations—Purification of Oil of Turpentine—Safe process for manufacturing Gunpowder—Fulminic acid and Fulminates, vol. xxi, pp. 288-295.

VI. Bibliography.

1. *The Sailor's Horn-Book for the Law of Storms*, being a Practical Exposition of the Theory of the law of Storms, and its uses to Mariners of All Classes in All Parts of the World, shown by Transparent Storm Cards, and Useful Lessons; by Henry Piddington, President of Marine Courts of Enquiry, Calcutta.—308 pp. 8vo, with 4 Maps, and 2 Horn-Cards.*—No work has appeared of late years, tending more to promote the interests of navigation and the welfare of seamen, than this volume by Mr. Piddington. It is written for practical men, in plain and forcible English, with full illustrations and directions, and with all the details required by the sailor in his voyages over the world. And if taken and carefully studied, it may be made a safe guide from the violence of gales and hurricanes, and prevent at least four-fifths of all the shipwrecks that happen in the open ocean. It teaches that hurricanes have their courses, and a certain regular system in their winds, and that while a prolonged storm, resulting perhaps in disaster, may await the ship that drives on without knowledge, a speedy escape is nearly certain, if one or two simple rules are regarded. Indeed the mere placing of a piece of horn marked with the requisite circles, upon a map over the position of the vessel, enables the sailor to see at a glance the course he must take to avoid the storm; and often he thus may even make its violence contribute to hasten him on his course.

The author observes in his Preface, "I know that many forget that a hurricane at sea is like 'a battle in a campaign;—an important though unfrequent occurrence for which it is wise to be well prepared;' and, rarely looking at works like the present till they want assistance from them, are thus very liable to mistakes in a moment of anxiety. If such however, will but give it one fair perusal at leisure, they may find perhaps—recollecting with quaint old Thomas Fuller, that 'the winds are not only wild in a storm, but even stark mad in a hurricane'—that a little study in fine weather may save a world of labor and mischief in bad."

This work therefore claims attention as an invaluable contribution to the interests of humanity as well as commerce. It teaches how to wield the storm, or avert its fury; and it is a work of benevolence to place this knowledge within the reach of those who are so often at the mercy literally of the winds and waves. No mate, much less captain, should be allowed, without a familiarity with the facts here detailed, to have the control of a ship and the lives it contains.

The introduction of new ideas will encounter prejudices. As Mr. Piddington mentions, even the variation of the compass was once written against as an absurdity, and Mercator's projection was pronounced as only fit for land-lubbers! "We must expect," he adds, "to find many 'of the old school' who 'do not like new-fangled notions,' many who 'do not like to be put out of their way,' many who 'think the old plan is good enough,' and that 'hit or miss, for luck's all,' is quite enough with a stout ship and a good crew; and to conclude, many who are too proud, too ignorant, or too indolent to take the trouble to learn. From such we can only entreat a patient hearing; and if, by chance,

* Published at Calcutta, and also by Wiley in New York.

they have lost a mast or two in a hurricane, quote to them the assurance of Poor Richard, that 'they that will not be counselled cannot be helped,' and further, that 'if you will not hear reason, she will assuredly rap your knuckles'—in the next hurricane."

The views entertained in Mr. Piddington's work are not novel to the American public;—or at least they ought not so to be: for they have been propounded and dwelt on at great length in this Journal, with abundant details and numerous illustrations. Here, in fact, they were first presented to the world. Mr. William C. Redfield, of New York, is the acknowledged author: severely and successfully has he labored, to ascertain the truth and make it useful to navigators. In his historical remarks, Mr. Piddington cites several authors of the past century, who had suggested that the violent storms at sea were rotary gales,* and then observes that—

"Up to the first ten years of the present century, all that appears known and published of tropical storms and hurricanes was that they were often great whirlwinds. Franklin had indeed shown in 1760, that the northeast storms of the American coast came from the S.W., but he did not prosecute the enquiry farther.

"Fortunately for science, however, Mr. William C. Redfield, of New York, had his attention drawn to the subject in the course of his professional pursuits as a Naval Architect, and in 1831 published in the 'American Journal of Science' a valuable paper, the first of a numerous series which has since followed, in which he demonstrated not only that the storms of the American coast were whirlwinds, but moreover that they were *progressive* whirlwinds moving forwards on curved tracks at a considerable rate, and were traceable from the West Indies and along the Coast of the United States till they curved off to the eastward between the Bermudas and the Banks of Newfoundland. He also gave many excellent practical rules for the management of ships, so as to avoid, or at least to diminish, the chances of damages from rotary storms, with valuable remarks on the barometer as a guide.†

"In an able article on the Law of Storms in the 'North American Review,' for April, 1844, is the following, which is not only part of the history of our science, but moreover a well merited tribute to the labors of the gentleman named in it—and I do not mean here to speak with less respect of those whose views have, I think, been proved erroneous. No one can have undertaken independent researches in any branch of the physical sciences without soon feeling that mankind owe much more than is usually supposed to those who have missed their road; they are the soldiers who have fallen, the successful are the victors who survive to reap the honors of the combat.

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* He mentions that Colonel Capper, in 1801, speaks of the Madras and Coromandel coast hurricanes as "whirlwinds whose diameter cannot be *more* than 120 miles, and the vortex seems generally near Madras or Pulicat."

† Mr. Redfield's papers in this Journal, are contained in volumes xx, 17; xxi, 191; xxv, 114, 122; xxviii, 154; xxxi, 115; xxxiii, 50; xxxv, 201; xxxvi, 50, 59; xli, 69; xlii, 112, 299; xliii, 250, 263; xliv, 384; xlv, 293; also in ii series, vol. i, 153, 333; ii, 162, 311.

"About the time that the American philosopher, Redfield, was employed in his earlier labors of observing and collecting the observations of others, a similar inquiry was in progress in Germany. On Christmas eve, 1821, after a long continuance of stormy weather, the barometer sank so low in Europe, that the attention of meteorologists was strongly drawn to the circumstance. M. Brande, having obtained the registers kept at this time in various places, came to the conclusion, that, during this storm, the winds blew from all points of the compass towards a central space, where the barometer was, for the moment, at its lowest stand. This conclusion was disputed by Professor Dove, of Berlin, who subjected the observations in the possession of Brande, as well as others, to a new examination, and made it appear, that an explanation of all the phenomena was afforded by the assumption of one or more great rotary currents, or whirlwinds, advancing from the southwest to the northeast.* Before this discussion was known in the United States, Mr. Redfield, by an independent course of investigation, had arrived at the result we have already announced, and his opinion is fortified by facts and cases so numerous and well authenticated, as fully to justify the distinction which Sir David Brewster has accorded to him in the following language,—'The theory of rotary storms was first suggested by Colonel Capper, but we must claim for Mr. Redfield the greater honor of having fully investigated the subject, and apparently established the theory upon an impregnable basis.'"†

"Mr. Redfield was followed in 1838 by Lieut. Col. Reid of the Royal Engineers, who published the valuable and well known work usually called 'Reid on the Law of Storms,' in which he not only fully confirmed Mr. Redfield's views, but added most extensively to the proofs of them, by investigations of the West Indian Hurricanes, and those of the Southern Indian Ocean, and moreover by proving farther what Redfield had already announced theoretically, that in the Southern Hemisphere the storms revolve in a contrary direction to those in the Northern one."

The work of Lieut. Col. Reid is a thick octavo volume, (436 pp.,) published in England, after an extended investigation of the Atlantic Storms, and a study also of those of the Southern hemisphere. The volume brought out the practical character of the principles, and contained rules for the direction of a ship when a storm is encountered. The researches of Mr. Redfield are detailed at length, and were the basis of the work.

In 1845, Dr. A. Thom, of H. M. 86th Regt., published a valuable work on the science generally, but more particularly relating to the Storms of the Mauritius and Southern India, presenting facts supporting the same theory as regards the rotary character of storms.

Mr. Piddington is not a mere collator of others' labors. On the contrary, his own investigations have been extensive, forming "a considerable portion, as to bulk at least, of the evidence new and corroborative upon which this science rests." More than this, they have brought to light much that was new as regards general truths. His memoirs, four-

* London and Edinburgh Journal of Science, Nos. 67, 68.
† Philosophical Magazine, vol. xviii, 3d series, p. 515.

teen in number, are published in the Journal of the Asiatic Society, volumes viii to xiv, and if collected together would make a volume of 650 pages, with 30 plates and diagrams.

The simplicity of his explanations and instructions, no less than the thoroughness of his work, evince the author's learning, acumen, and good judgment. We may dissent from one or two of his deductions, but these points, if incorrect, do not affect the practical value or interest of the work.

Mr. Piddington calls a great rotary storm or hurricane a *Cyclone*, a word derived from the Greek κυκλος, *circle*. After devoting twenty pages to an historical account of this branch of meterology, and a notice of different theories, he passes to Part II, in which he enters upon the descriptive and explanatory part of the subject. Considering the general principle well established, that the gales of the two hemispheres revolve in opposite directions, those of the southern *with* the hands of a watch, and those of the northern the reverse, he points out the several well ascertained tracks of gales over the globe, referring largely to facts and authorities, describes the general characters of storms in the different regions, and mentions the average rates and sizes of hurricanes in the various seas, and the peculiarities they present. We have not space to give an abstract of the work; neither is it necessary, as the volume may be had by all who desire to study the subject.

Part III, occupying pages 64 to 125, contains practical directions for avoiding storms and turning them to account.

Part IV, pp. 126 to 176, treats of previous phenomena attending storms; the storm wave and storm current; passage of the centre of storms; electrical or magnetic effects; arched squalls and tornados.

Part V, (the concluding 116 pages,) explains the value and uses of the barometer and sympiesometer, and the changes they indicate during gales: it treats also of the height of storms; signs of their approach; water spouts; formation and breaking up of hurricanes; besides other topics of interest.

The mode of using the storm cards will be gathered from Mr. Redfield's figures in this Journal, p. 333, vol. ii, 1846; for the circles marked on the cards are similar to the figures here referred to. They are, in fact, plans of hurricanes. Being made of transparent horn—for which idea we are indebted to Mr. Piddington—they are extremely convenient in use. If a vessel, for example, near the Bermudas, feels an approaching hurricane, and has the wind blowing southeast, the horn-card is laid on the chart, placing any point in that radius which corresponds to *wind S.E.* over the point marked for the position of the vessel. This being done, it is at once observed that the body of the cyclone is in this case off to the southwest; farther, that by running west, the vessel will be driving into the fiercest of the gale; by going north, she will also encounter its violence and prolong its continuance; by going southeast, she will dodge it entirely, or feel only its exterior winds. It is a fact previously known for these seas, that the gales have a course to the northward or northward and eastward. In the same manner, the cards may be used for other regions. Mr. Piddington's illustrations leave nothing to be desired in the way of fullness and simplicity.

We leave the work, again commending it strongly to all who own vessels on the ocean, as well as to those who command them, urging

that no ship be sent to sea without a barometer, and a good supply of copies of "The Sailor's Horn Book of Storms."

2. *Memoir, Geographical, Political and Commercial, on the Present State, Productive Resources and Capabilities of Siberia, Manchuria, and the Asiatic Islands of the Northern Pacific Ocean; and on the importance of opening Commercial Intercourse with those Countries, &c.* Addressed to his Excellency, JAMES K. POLK, President of the United States; by AARON H. PALMER, Counsellor of the Supreme Court of the United States, &c. March 8, 1848. Referred to the Committee on the Library and ordered to be printed. 106 pp. 8vo.—The author of this Memoir has embodied in a few condensed pages, a large amount of information on the countries of which he treats, and urges with arguments meriting attention, the importance of opening commercial intercourse with regions yet unvisited, and revising the arrangements existing with other distant nations. He suggests the importance of an early revision of our commercial convention with Russia of the $\frac{17}{29}$th April, 1824, for the admission of our vessels into the ports of Siberia, Kamschatka, the Kurile and Aleutian Islands, and the North Pacific, as well as the Russian settlements of Northwestern America. He observes that it is "equally important that our government should insist on the right of navigating the great Manchurian river Amúr and its affluents, and of trading with the colonial dependencies of China, upon the same footing as the Russians; and that we claim the further privilege of commercial intercourse at Tinghae, in the Chusan Archipelago. The favorable position of that port, with its safe anchorages, accessible to the largest ships at all seasons, lying near the embouchure of the great Yangtsekang river, and within two days' sail of Japan and Corea, give it superior advantages over every other port in China for trade, and as a depot and halting station for the American trans-Pacific line of steamers, which it is contemplated to establish between Panama and China, in connexion with the line now in progress from Panama to Oregon."

The Memoir is an extract, as Mr. Palmer states, from a work entitled "The Unknown Countries of the East," which he proposes to publish. The extensive geographical learning of its author, and his wide reach of mind, must render the work one of high value both commercially and geographically. From the Prospectus, we learn that it embraces descriptions of the features and resources of Ascension Island, St. Helena, Colony of the Cape of Good Hope—East Coast of Africa—Zanguebar—Comoro Islands—Island of Madagascar—Mauritius—Bourbon—Abyssinia—Red Sea—Ports on the African Coast—Arabia—Persia—Belouchistan, Sinde, Punjaub, Afghanistan—Hindostan—Burman Provinces—various islands of the Indian Archipelago, with an account of the steam communication between England, Singapore and Australia—North and Northeast coasts of Australia—Loochoo, and Bonin Islands, Japan, Kuriles, Yeso, Saghalien and other islands east of Asia—Manchuria and other Colonial Dependencies of China—Siberia, and the Russian Trade with China at Kiatka. An appendix includes memoirs on the steam navigation of the Pacific—on a ship canal from the Atlantic to the Pacific—a proposed mission to the East, and Consular plan for a portion of the countries described—with a catalogue of the authors consulted in preparing the work.

3. *Memoirs of the American Academy of Arts and Sciences*, New Series. Vol. III. Cambridge and Boston: Metcalf & Co., Printers to the University. 4to, pp. lxxxii and 290, with 45 plates.—The appearance of this volume, filled as it is with substantial and important contributions to science, is a gratifying proof of the efficient condition of this long established Academy.

The eloquent and discriminating eulogy on Hon. John Pickering, LL.D., President of the Academy, by Judge White, forms an appropriate introduction to the volume. Mr. Pickering was a noble example of the Christian philosopher—eminent alike in all that could adorn the scholar, the jurist, and the man of science. Judge White's eulogy upon this great and good man has been extensively read in the form in which it appeared soon after its delivery in October, 1846. It now for the first time, takes its appropriate place in the Memoirs of the Academy. It is followed by—

I. Chloris Boreali-Americana: Illustrations of new, rare or otherwise interesting North American plants, selected chiefly from those recently brought into cultivation at the Botanic Garden of Harvard University, Cambridge. By Asa Gray, M.D. Decade I, (with 10 plates.) p. 1.

II. Contributions to the Bryology and Hepaticology of North America. By William S. Sullivant, A.M. Part I, (with 5 plates.) p. 57.

III. Occultations and Eclipses observed at Dorchester and Cambridge, Massachusetts, by William Cranch Bond, Director of the Observatory, Wm. C. Bond, Jr., and George P. Bond. p. 67.

IV. An account of the Nebula in Andromeda. By George P. Bond, Assistant at the Cambridge Observatory, (with 1 plate.) p. 75.

V. Description of the Nebula about the Star θ Orionis. By Wm. Cranch Bond, Director of the Cambridge Observatory, (with 1 plate.) p. 87.

VI. Some Methods of Computing the ratio of the distances of a Comet from the Earth. By George P. Bond, Assistant at the Cambridge Observatory. p. 97.

VII. An Attempt to discriminate and describe the animals that made the Fossil Footmarks of the United States, and especially of New England. By Edward Hitchcock, D.D., LL.D., President of Amherst College, etc., (with 24 plates.) p. 129.

VIII. On Platygonus compressus: a new Fossil Pachyderm. By John L. LeConte, M.D., (with 4 plates.) p. 257.

Appendix.—Report on the discovery and Nomenclature of the Eighth Satellite of Saturn. By Edward Everett, LL.D. p. 275.

This volume is brought out with all the mechanical attractions of good paper and perspicuous type, and the plates are many of them very beautiful, especially the botanical and astronomical ones.

It is very gratifying to observe the impulse which this Society has received within the last few years—an impulse which reacts strongly to concentrate and render available the scientific research of New England especially. At no former period has the effective scientific force of the New England metropolis and her venerable University been so great or so active as at present.

The discovery of the new Satellite of Saturn, Hyperion, by Mr. George P. Bond, has already been noticed by us. The near coin-

cidence in the discovery of this satellite by Mr. Bond, at Cambridge, and by M. Lassell, at Starfield near Liverpool, England, (the first on the 16th, and the second on the 18th of September,) leaves to each the credit of an original discoverer, although the honor of priority plainly belongs to Mr. Bond. We are informed in this Appendix, that Mr. Bond is preparing a memoir to be presented to the Academy at a future day, containing in full the observations of Saturn, his rings, and satellites, made at the Observatory in Cambridge during the past year.

4. *An Elementary Treatise of Spherical Geometry and Trigonometry;* by ANTHONY D. STANLEY, A.M., Prof. of Mathematics in Yale College. 122 pp. 12mo. New Haven, 1848. We may commend this Treatise to the various institutions of our land, as an excellent manual for instruction in spherics. The definitions are clear and direct, and the demonstrations extend over as wide a range as can be desired for the general student. The first 54 pages are occupied with spherical geometry, and the remainder with spherical trigonometry.

5. *The Philosophy of Geology;* by A. C. G. JOBERT, late editor of the 'Journal de Geologie,' one of the authors of 'Recherches sur les Ossemens Fossiles du Puy-de-Dôme.' 2d ed. 184 pp. 18mo. *London* and *Paris.* 1847.—Also, *Ideas or Outlines of a new System of Philosophy;* by A. C. G. JOBERT, &c. 141 pp. 18mo, *London.* 1848.—Mr. Jobert in his Philosophy of Geology, commences by combating the doctrine of the eternity of the actual course of nature, and the view that the idea of a cause is based on the invariability of an antecedent and its consequent. He discusses and rejects the Huttonian dogma that the granitic material of our globe is but a re-fusion of previous rock-material, a theory which implies an eternity of causation. The author proceeds to a course of argument with reference to the relations and origin of the various strata of the globe; and although we cannot agree with him in all his steps, we fully assent to the result of the whole—that the phenomena of existences are not the consequence of an eternal law of invariable revolutions, but the acts of a Supreme Providence, who has directed matter in its transformations, and left, from period to period, visible traces of his power, his solicitude, and his munificence. The Second work on Ideas, continues the same topic, being an examination of the natural and philosophical ground of the idea of a God.

6. *Observations on Belemnites and other Fossil Remains of Cephalopoda, discovered by Mr.* REGINALD NEVILLE MANTELL, C.E., in the Oxford clay near Trowbridge, in Wiltshire; by GIDEON ALGERNON MANTELL, Esq., LL.D., F.R.S., F.L.S., and Vice President of the Geological Society.—This memoir, containing eleven pages, is published in the Philosophical Transactions, Part II, for 1848, and is illustrated by three quarto lithographic plates. Much light is here thrown upon the structure of the animal of the Belemnite, now known to be a cephalopodous mollusc. It is almost unnecessary to say that the memoir is characterized by the well known ability and accuracy of the distinguished author.

7. *A Memoir on the Structure of the Maxillary and Dental organs of the Iguanodon;* by G. A. MANTELL, &c.—This memoir is also from the Philosophical Transactions for 1848, Part II. It occupies ten pages, with four lithographic plates, one of which is folded and

presents a fac-simile both for size and form of the portion of the lower jaw of the Iguanodon, which is the principal subject of the memoir. An abstract is given in our last number, vol. vi, p. 429.

8. *A Memoir on the Dinornis*, Part III, containing a description of the skull and beak of that genus, and of the same characteristic parts of the *Palapteryx*, and of two other genera of birds, *Notornis* and *Nestor;* forming part of an extensive series of Ornithic remains, discovered by Mr. Walter Mantell, at Waingongoro, North Island of New Zealand; by Professor Owen, F.R.S., F.Z.S., &c. &c., pages 33, with five quarto lithographic plates.—We have barely room at this time, to announce the appearance of this memoir. The great interest of the New Zealand fossils renders these among the most important of the valuable labors of Professor Owen.

9. *Collections of the Georgia Historical Society*, Vol. III, Part I.—A spirit of enquiry has been growing more and more active for some time, regarding the history of the different States of the American Union, and we have perused with satisfaction the previous volumes published by the Georgia Historical Society, which have thrown great light upon the history of that state.

The present publication consists chiefly of the papers of the late Col. Hawkins, long known as a successful agent among the Indians of the southern part of the continent, with whom he had great influence.

We are much impressed by the picture which these documents present, of numerous Indian settlements existing at the close of the last and the beginning of the present century, in many places in the higher regions of Georgia; settlements marked by considerable advances in civilization, and in the means and habits of regular and comfortable living, with dawning institutions for civil government and instruction.

How great the change in fifty years! A stern policy has removed the remnants of these tribes beyond the Mississippi. It is still to be hoped that they may be redeemed from the habits of savage life and elevated to the standard of civilized and Christian nations.

10. *Memoirs read before the American Association for the Promotion of Science.*—The following memoirs by Mr. James Hall, were not included in the list given on page 393, of last volume.

I. On the tracks or trails in sandstone of the Clinton Group, of New York, indicating the existence of beaches and the frequent alternation of beds thus marked, proving the occurrence of tides. [?]

II. On some bivalve shells of large size from the Onondaga Salt Group. These shells are interesting, from being closely allied to Devonian types—Ex. Megalodon.

III. On the petrifaction of the soft parts of the Orthoceras and other shells.

D. P. Gardner: Medical Chemistry, for the use of Students and the Profession, being a Manual of the science, with its applications to Toxicology, Physiology, Therapeutics, Hygiene; by D. P. Gardner, M.D., formerly Professor of Chemistry in the Philadelphia College, &c. &c. pp. 396, large 12mo, with numerous wood-cuts.

James Hall: Address delivered at the Anniversary Meeting of the Harvard Natural History Society, May 24, 1848, by James Hall, Geologist and Palæontologist of the Geological Survey of the State of New York. 40 pp. 8vo. *Cambridge*, 1848.

C. B. Adams: Third Annual Report on the Geology of Vermont. 32 pp. 8vo. *Burlington*, 1847.

F. S. Holmes: Notes on the Geology of Charleston, S. C., 18 pp. 8vo.—A valuable memoir on the post-pliocene and tertiary and general features of the country about Charleston, South Carolina.

R. D. Thomson, M.D., of Glasgow: School Chemistry, or Practical Rudiments of the Science. fcp. 8vo.

J. H. Coffin: Elements of Conic Sections and Analytical Geometry. 158 pp. 8vo. *New York*, 1848. Collins & Brother.

W. J. Simmonite: Medical Botany. 12mo. *London*, 1848. 3*s.* cl.

Report from the Acting Secretary of the Treasury, communicating the Annual Report of the Commissioner of the General Land Office; with Reports of the Surveyor General accompanying the Annual Report; also Preliminary Reports containing outlines of the progress of the Geological Survey of Wisconsin and Iowa, up to October 11, 1847, by D. D. Owen and C. T. Jackson, and the Assistants in the Survey, Dr. Locke, Dr. Wm. F. Channing and J. D. Whitney. Senate Executive Document, No. 2, 30th Congress, 1st Session.

H. R. Schinz: Monographien der Säugethiere, mit Abbildungen von J. Kull. Heft 18, *Zurich*, 1848. Kl. Fol. 6 Tfln. ill.

J. H. Hasskarl: Plantæ javanicæ rariores, adjectis nonnullis exoticis in Javæ hortis cultis, descriptæ; 8vo, 554 pp. *Berolini* apud Förstner, 1848.

Jules Marcou: Recherches geologiques sur Le Jura Salinois;—From the Transactions of the Geological Society of France. Read before the Society in May and November, 1846. 151 pp. 4to, with maps.

J. C. Maly: Enumeratio plantarum phanerogamicarum Imperii Austriaci universi. *Vindobonæ* (Vienna) Braumäller u. Seidel.

C. Ch. Beinert: Der Meteorit von Braunau, am 14 Juli, 1847. 3 taf. Breslau, Trewendt in Comm.

O. B. Kuhn: System der anorganischen Chemie als Leitfaden zum Studium der theoret. Chemie bearb. *Göttingen*, Vandenhoeck u. Ruprecht.

H. Burmeister: Geschichte der Schöpfung, eine Darstellung des Entwicklung-Ganges der Erde und ihrer Bewohner. 3 Aufl. mit 228 Holzschnitten. 8vo. *Leipzig*, 1848.

Annales des Sciences Naturelles, Tome ix, 3e Ser. MARCH, 1848.—On the structure of the liver of Vertebrata (continued); N. Guillot.—On the Organization of Gasteropoda, order "Opisthobranches"; E. Blanchard.—New genus of Decapadous Crustacea; M. Edwards.—Mycological fragments (continued); J. H. Léveillé.—New or little known Eryngia; J. Gray.—On a new genus of Orobancheæ; E. Cosson.—On the Droseraceæ (continued); J. E. Planchon.—APRIL. New species of Sorex from Madagascar; Ch. Coquerel.—Metamorphosis of Brachyopa bicolor; L. Dufour.—Ibid, Cheilosia ærea; L. Dufour.—On genus Macrodontia, family Prionidæ; E. Blanchard.—Researches on Zoophytes ("Les Polypiers") 2d memoir; M. Edwards and J. Haime.—Monograph of the Turbinolidæ.—On the Droseraceæ (continued); J. E. Planchon.—Morphological and physiological observations on some species of cultivated gourd; G. Gasparrini.—New genus of Cucurbitaceæ, proposed; G. Gasparrini.—Anatomy and organogeny of Trapa natans; F. M. Barnéoud.—Mycological fragments (continued); J. H. Léveillé.—MAY. Researches on Zoophytes ("Les Polypiers"); M. Edwards.—Mycological fragments (continued); J. H. Léveillé.—Floral organogeny and embryogeny of the Nyctagineæ; P. Duchartre.—On the Droseraceæ (continued); J. E. Planchon.—New species of Plants.

Korrespondenz-Blatt des zoologisch-mineralogischen Vereins in Regensburg. *Regensburg*. 8vo. 1847. No. I–VI, S. 1–80, [1 fl. 48 kr.]—Geognostische Verhältnisse der Umgegend von *Passau* und des *Baierischen Waldes* oder des *Böhmer-Gebirges*: 29–32, 44–48; *Waltl.*—Notitz über ein merkürdiges Lager fossiler Pflanzen bei *Culmbach*: 32.—Das Vorkommen des Magnet-Eisensteins im Übergangs-Gebirge in *Böhmen*: 36–41; *J. Micksch.*—Fährten von Chirotherium Barthii u. A. im Bundsandstein bei *Culmbach*: 50.—Vorkommen des Retinasphaltes und des Bleiglanzes in der Steinkohlen-Formation von *Pilsen*, nebst einer geognostischen Skizze. 70–80. Tf. I; *J. Micksch.* (Neues Jahrb. of Leonhard and Bronn.)

Nyt Magazin for Naturvidenskaberne, etc. *Christiania*. 8vo. 1846. V, I, S, 1–88, Tf. I. in fol.—Versuch einer geognostisch-mineralogischen Beschreibung der Kobalt-Gruben bei *Modum*, mit Karte: S. 1–32; *K. F. Bøbert.*—Gesetze für die Fortpflanzung des Lichts in isophanen und einachsig krystallisirten Körpern: S. 48–88. (Neues Jahrb. of Leonhard and Bronn.)